



Final Updated Environmental and Social Impact Assessment

Aurora Gold Project

Prepared for



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1	Introduction	1-1
1.1	General Background	1-1
1.2	Regulatory Setting	1-6
1.3	Resolution of Comments from IFC Review of ERM (2010)	1-8
1.4	Organization of ESIA Report	1-21
2	Project Description	2-1
2.1	Project Setting	2-2
2.1.1	Geographical and Geological Setting	2-1
2.1.2	Environmental Setting	2-6
2.1.3	Social Setting	2-6
2.2	Early Works Construction Phase	2-9
2.3	Major Construction Phase	2-9
2.3.1	Cuyuni River Dike Construction, Airstrip Renovation, and Open Pit Area Clearances	2-9
2.3.2	Mine Waste Rock Stockpile Footprint Preparation	2-12
2.3.3	Mill Area Infrastructure Construction	2-12
2.3.4	Tailings and Reclaim Pipeline and Initial Tail Mining Area (TMA Clearance and Construction	2-14
2.3.5	MWP and Fresh Water Pond (FWP) Clearance and Construction	2-15
2.3.6	Underground Mine Construction	2-15
2.3.7	Man-Camp Completion	2-15
2.3.8	Decommissioning and Closure of Tapir Camp	2-16
2.3.9	Final Construction Activities, Buckhall	2-16
2.4	Operational Phase	2-17
2.4.1	Power Generation	2-17
2.4.2	Open Pit Mining Operations	2-17
2.4.3	Underground Mining Operations	2-18
2.4.4	Mineral Processing Operations	2-20
2.5	Decommissioning, Reclamation, and Closure Phase	2-23
2.6	Post-closure Phase	2-29

3	Alternatives Assessment	3-2
3.1	Environmental Footprint Reduction	3-2
3.2	Description of Changes in Major Project Components	3-2
3.2.1	Open Pits	3-9
3.2.2	Tailings Mining Area (TMA)	3-9
3.2.3	Mine Water Management, Diversion, and Fresh Water Ponds	3-9
3.2.4	Waste Rock, Saprolite, and Overburden Stockpiles	3-10
3.2.5	Man Camp	3-10
3.2.6	Airstrip	3-10
3.2.7	General Industrial Areas – Mineral Processing and Support Facilities	3-10
3.2.8	Cuyuni River Dike System	3-10
3.2.9	Internal Roads	3-10
3.2.10	Power Generation Alternatives, Energy Demand, and Fuelling Schemes	3-11
3.2.11	Access to Aurora Site	3-11
3.3	Summary of Advantaages of the Selected Alternatives	3-11
4	Environmental Baseline	4-6
4.1	Area of Influence	4-9
4.2	History of Baseline Data Collection	4-12
4.2.1	Groundwater Sampling	4-12
4.2.2	Surface Water/Sediment Sampling	4-12
4.2.3	Biological Sampling	4-12
4.3	Climate	4-14
4.4	Air Quality	4-17
4.5	Hydrology	4-18
4.5.1	Surface Waters	4-18
4.5.2	Groundwater	4-21
4.5.3	2011 Investigation	4-24
4.6	Water Quality	4-27
4.7	Geology	4-43
4.7.1	Structural Geology	4-44
4.7.2	Geomorphology and Soils	4-47
4.7.3	Acid Rock Drainage and Metal Leaching Studies	4-49
4.8	Biodiversity	4-49
4.8.1	Scope of Biodiversity Assessment	4-49
4.8.2	General Characterization of the Region	4-50
4.8.3	Biological Sampling of the Study Area	4-52
4.8.4	Regional and Biogeographic Settings	4-53
4.8.5	Biological Sampling Methodologies	4-58
4.8.6	Biological Sampling Results	4-65
4.8.7	Fish	4-70
4.8.8	Amphibians	4-73
4.8.9	Non-avian Reptiles	4-76
4.8.10	Birds	4-78
4.8.11	Mammals	4-90
4.8.12	Species Accumulation Curves	4-95

4.8.13	Invasive Alien Species	4-96
4.8.14	Critical Habitat Assessment	4-96
4.8.15	Legally Protected and Internationally Recognized Areas	4-116
4.8.16	Ecosystem Services	4-119
5	Socioeconomic Baseline	5-1
5.1	Introduction and Methodology	5-1
5.2	National Context	5-2
5.3	Regional Context	5-2
5.4	Social Area of Influence	5-3
5.5	Communities Studied in the Baseline	5-5
5.5.1	Communities in the DAI	5-5
5.5.2	Detailed Baseline for Communities in the Project's DAI	5-6
5.5.3	Communities in the Project's IAI	5-20
5.5.4	Other Project Beneficiaries	5-22
5.5.5	Summary of Findings	5-24
6	Risk and Impact Assessment	6-2
6.1	Introduction	6-2
6.2	Application of the Mitigation Hierarchy in Development of Project Design	6-3
6.3	Risk and Impact Assessment Methodology	6-4
6.3.1	Risk and Impact Screening	6-4
6.3.2	Quantification of Risk and Impact Significance	6-4
6.3.3	Consideration of Residual Impacts	6-23
6.4	Cumulative Impacts	6-24
6.4.1	Definition and Assessment Approach	6-13
6.4.2	Cumulative Impacts on the Physical and Biological Environment	6-14
6.4.3	Cumulative Socioeconomic Impacts	6-15
7	Assessment and Management Environmental and Social Risks (Ref: IFC PS-1)	7-2
7.1	Summary of PS 1 Requirements	7-2
7.2	Project ESMS Description	7-2
7.2.1	ESMS Plan	7-9
7.2.2	Management and Mitigation Plans	7-9
7.2.3	Standard Operating Procedures	7-16
8	Labor and Working Conditions (Ref: IFC PS-2)	8-2
8.1	Summary of PS 2 Requirements	8-2
8.2	Working Conditions and Management of Workforce Relationships	8-2
8.2.1	Human Resources Policies and Procedures	8-2
8.2.2	Working Conditions and Terms of Employment	8-3
8.2.3	Workers' Organizations	8-4
8.2.4	Non-Discrimination and Equal Opportunity	8-4
8.2.5	Retrenchment	8-4
8.2.6	Grievance mechanism	8-5
8.3	Workforce Protection	8-5

8.4	Occupational Health and Safety	8-5
8.5	Workers Engaged by Third Parties	8-9
8.6	Supply Chain Considerations	8-10
9	Resource Efficiency and Pollution Prevention (Ref: IFC PS-3)	9-3
9.1	Summary of PS 3 Requirements	9-3
9.2	General Resource Efficiency Considerations	9-3
9.2.1	Power Generation, Fuel Use, and Minimization of GHG Emissions	9-4
9.2.2	Use of Water Resources	9-4
9.3	Pollution Prevention	9-9
9.3.1	Air Quality Management Strategy	9-10
9.3.2	Water Quality Management	9-10
9.3.3	Land Impact Management Strategy	9-33
9.4	Management of Pesticides	9-38
10	Community Health, Safety and Security (Ref: IFC PS-4)	10-2
10.1	Summary of PS 4 Requirements	10-2
10.2	General Considerations – Health and Safety of Affected Communities	10-2
10.3	Safety Considerations in Infrastructure and Equipment Design	10-2
10.4	Hazardous Materials Management	10-5
10.5	Adverse Community Health and Safety Risk in Provisioning and Regulating (Ecosystem) Services	10-8
10.6	Community Exposure to Disease	10-9
10.6	Emergency Preparedness and Response	10-10
10.7	Security Services	10-11
11	Land Acquisition and Involuntary Resettlement (Ref: IFC PS-5)	11-2
11.1	Summary of PS 5 Requirements	11-2
11.2	Applicability of PS 5 to Project	11-2
11.3	Displacement Potential in Project Design	11-4
11.4	Compensation and Benefits for Displaced Persons	11-4
11.5	Community/Stakeholder Engagement	11-5
11.6	Grievance Mechanisms	11-5
11.7	Resettlement and Livelihood Restoration Considerations	11-5
12	Biodiversity Conservation and Sustainable Natural Resource Management (Ref: IFC PS-6)	12-2
12.1	Summary of PS 6 Requirements	12-2
12.2	Protection and Conservation of Biodiversity	12-3
12.2.1	Modified Habitat	12-3
12.2.2	Natural Habitat	12-3
12.2.3	Critical Habitat	12-4
12.3	Invasive Alien Species	12-4
12.4	Management of Ecosystem Services	12-5
12.5	Sustainable Management of Living Natural Resources	12-6

12.6	Supply Chain Considerations	12-6
13	Indigenous Peoples (Ref: IFC PS-7)	13-1
13.1	Summary of PS 7 Requirements	13-1
13.2	Applicability of PS 7 to Aurora Gold Project	13-1
13.3	Other Considerations Involving Indigenous Peoples	13-4
14	Cultural Heritage (Ref: IFC PS-8)	14-1
14.1	Description of Cultural Heritage Considerations in Area Affected by Project	14-1
14.2	Protective Measures for Cultural Artifacts	14-2
15	Master Reference List	15-2

List of Tables

Table 1.2-1:	Summary of Major Permit and License Requirements - Aurora Gold Project
Table 1.3-1:	Concordance Table: Resolution of IFC Comments on Original ESIA
Table 2.1.3.2-1:	Estimated Life of Mine Staffing Levels – Aurora Gold Project
Table 3.1:	Comparison of Major Project Alternatives
Table 3.1.2:	Comparison of Modified and natural Habitats and Streams to Be Converted by Mine Footprint and Internal Roads for July 2010 and January 2013 Site Layouts
Table 4.2-1:	History of biodiversity field surveys in the vicinity of the Aurora Project site, 2006 to 2012
Table 4.3-1:	Summary of average monthly climate data from the Aurora Station from June 2006 to September 2011
Table 4.3-2:	Overall 2006-2011 summary of available climate data from the Aurora Station
Table 4.5-1:	Depth to groundwater in meters
Table 4.5-2:	Summary of hydraulic conductivities in centimeters per second
Table 4.5-3:	Locations, depths, and identification of well nests at Aurora and formation in which each is screened
Table 4.5-4:	Groundwater elevations and hydraulic conductivity in centimeters per second (cm/s) for each screened geologic formation at Aurora
Table 4.6-1:	Surface water analytical results in milligrams per liter (mg/L), February 10, 2006
Table 4.6-2:	Surface water analytical results in milligrams per liter (mg/L), July 6, 2006
Table 4.6-3:	Surface water analytical results in milligrams per liter (mg/L), October 12, 2006
Table 4.6-4:	Surface water analytical results in milligrams per liter (mg/L), March 4, 2007
Table 4.6-5:	2009 Surface water analytical results
Table 4.6-6:	2009 sediment analytical results

Table 4.6-7:	Results of analytical tests on surface water samples at Aurora (2011).
Table 4.6-8:	Results of analytical tests on sediment samples at Aurora (2011).
Table 4.6-9:	Groundwater analytical results, February 10, 2006
Table 4.6-10:	Groundwater analytical results, July 6, 2006
Table 4.6-11:	Groundwater analytical results, October 12, 2006
Table 4.6-12:	Groundwater analytical results, March 4, 2007
Table 4.6-13:	2009 groundwater analytical results
Table 4.6-14:	Results of analytical tests on 2011 groundwater samples at Aurora
Table 4.7-1:	Major characteristics of soil types found on the project site
Table 4.8-1:	Description of Guiana Shield Initiative (GSI) priority areas in the Cuyuni and Mazaruni River basins
Table 4.8-2:	Primary transect locations and descriptions for 2011 wet season terrestrial surveys at the Aurora concession
Table 4.8-3:	Secondary transects established perpendicular to primary transects during 2011 wet season surveys at the Aurora concession.
Table 4.8-4:	2011 wet and dry season fish sampling dates, locations, sampling hours, and tackle
Table 4.8-5:	Dominant and frequently occurring plant species at Aurora during the 2011 dry season.
Table 4.8-6:	Fish sampled at Aurora during 2011 wet and dry season surveys
Table 4.8-7:	Summary of amphibians identified during 2011 wet and dry season surveys at Aurora
Table 4.8-8:	Migratory bird species reported from all surveys
Table 4.8-9:	Guianan Shield endemic bird species reported from the Aurora concession during all field surveys.
Table 4.8-10:	Bird species observed at Aurora during 2011 wet and dry season surveys
Table 4.8-11:	Non-chiropteran mammals observed during the 2011 surveys
Table 4.8-12:	Bats captured during the 2011 wet and dry seasons at Aurora
Table 4.8-13:	Freshwater fish species considered endemic to Guyana
Table 4.8-14:	Amphibians endemic to lowland (<500 masl) Guyana, the Guianan Moist Forests Ecoregion (GMFE), or with restricted ranges (<50,000 km ²) that include the Lower Cuyuni-Mazaruni Basins (adapted from Frost, 2009; Señaris & MacCulloch, 2005; and http://Intreasures.com/guyanaa.html)
Table 4.8-15:	Non-avian reptiles endemic to the Guiana Shield Region and known to be present in Guyana (adapted and updated from Avila-Pires, 2005)
Table 4.8-16:	Guiana Shield endemic birds (after Milensky et al., 2005)

Table 4.8-17:	Guiana Shield endemic mammals, after Lim et al. (2005)
Table 5.4-1:	Communities within the Social Area of Influence
Table 5.5-1:	Approximate Number of Adult Males, Adult Females, and Children Living in Aranka Mouth
Table 5.5-2:	Approximate Age Breakdown of Aranka Mouth Residents
Table 5.5-3:	Approximate Number of Adult Males, Adult Females, and Children Living in Buckhall
Table 5.5-4:	Approximate Age Breakdown of Buckhall Residents
Table 6.3.1	Significant Environmental and Social Risks and Impacts, Associated Management/Mitigation Measures, and Residual Impact Considerations
Table 6.4.1	Evaluation of Relative Significance of Cumulative Impacts
Table 7.1-1:	References for ESMS Management Plan Structure and Content
Table 7.2-1:	Management Plan Applicability over Mine Life Cycle
Table 7.3-1:	Standard Operating Procedures
Table 8.4-1:	OHS SOPs

List of Figures

Figure 1.1-1:	Aurora Gold Project Location
Figure 1.1-2:	Aurora Gold Project Location (Buckhall to Aurora Site Transportation Corridor)
Figure 1.1-3:	Aurora Gold Project Mine Site Layout, Concession Boundary, and Environmental AOI
Figure 2.1-1:	Aurora Gold Project – Aurora Mine Site Plan
Figure 2.1-2:	Mineralized Zones in the “Golden Square Mile”
Figure 2.1-3:	Local and Regional Geology, Aurora Gold Project
Figure 2.1-3:	Local and Regional Geology, Aurora Gold Project (Source: GGI)
Figure 2.1-4:	3-D Visualization of Mineralized Zones In relation to Conceptual Pit Boundaries
Figure 2.2-1:	Fuelling Trestle, Buckhall Logistics Support Facility
Figure 2.2-2:	New Administrative Buildings, Buckhall Logistics Support Facility
Figure 2.2-3:	Revegetated ROW Areas, Aurora M3 Road Extension – Example of Red Baromalli Tree Plantation
Figure 2.2-4:	New Modular Man-camp Under Construction, Aurora Site (2012)
Figure 2.4-1:	Conceptual View of Underground Mine
Figure 2.4-2:	Conceptual Plan View of Representative Sublevel in Underground Mine

- Figure 2.4-3: Conceptual Process Flow Sheet, Aurora Gold Project
- Figure 2.4-4: Conceptual Model of Aurora Gold Project Water Balance
- Figure 2.5-1: Project Configuration at Closure
- Figure 3.1-1: Project Location, Original Conceptual Design (AMEC, 2012)
- Figure 3.1-2: Project Location, Final Design (TetraTech, 2013a)
- Figure 3.1.3: Project Location, Final Design [from [TetraTech, 2013s) with GIS Overlay]
- Figure 3.1.4: Comparison of Project Envelopes (includes a 500-m buffer around mine footprint and internal roads)
- Figure 4-1: Regional Setting of the Aurora Concession and the Cuyuni River Basin on the Map of the World Wildlife Fund (WWF) Ecoregions of the Guyana Region.
- Figure 4.1-1: Project Layout and Area of Influence (Aurora Site to Tapir Crossing)
- Figure 4.1-2: Area of Influence for the Environmental Baseline and Other Features
- Figure 4.5-1: Hydrologic Map of the Aurora Concession (yellow polygon) and Surrounding Area.
- Figure 4.5-2: Mean Daily Flows (m^3/s) for the Kamaria Falls and Akarabisi Stations for the Period 1947–1989 (MWH, 2008)
- Figure 4.5-3: Mean Daily Flows (m^3/s) at the Aurora Mine Location for the Period 1947–1989 (MWH, 2008)
- Figure 4.5-4: Mean Daily Flows (m^3/s) of the Cuyuni River at the Aurora Mine Location for the Period April 2004 – August 2006
- Figure 4.5-5: Groundwater Monitoring Well Locations (indicated by green triangles on map).
- Figure 4.6-1: 2006–2007 and 2009 Surface Water and Sediment Sampling Locations.
- Figure 4.7-1: Soil Types within the Aurora Mine Area of Influence
- Figure 8-1: Regional Setting of the Aurora Concession and the Cuyuni River Basin on the Map of the WWF Ecoregions of the Guyana Region.
- Figure 8.1.1: Direct Area of Influence for the Environmental Baseline and Other Features including the Locations of Biodiversity Transects and Sampling Points and Routes Traveled Repeatedly during Field Work
- Figure 4.8-1: Guiana Shield Initiative (GSI) Priority Areas in the Cuyuni and Mazaruni River Basins.
- Figure 4.8-2: 2011 Wet and Dry Season Fish Sampling Locations in the Aurora Concession
- Figure 4.8-3: Number of New Species of Flora and Birds versus Sampling Years
- Figure 4.8-4: Number of New Species of Mammal, Amphibian, Reptile, and Fish versus Years of Survey
- Figure 4.8-5: Distribution of Localities for Missouri Botanical Garden Specimens of *Virola surinamensis* for which Coordinates are Available.

- Figure 4.8-6: Estimated Range of *Stefania evansi* (yellow polygon) and Aurora Concession (red polygon).
- Figure 4.8-7: Alliance for Zero Extinction Sites in the Guiana Shield Region.
- Figure 4.8-8: Alliance for Zero Extinction Sites in Northern South America, Mesoamerica, and the Caribbean.
- Figure 4.8-9: Protected Areas in Guyana and Adjacent Areas. Source: Data from 2009 World Database of Protected Areas
- Figure 5.4-1: Location of Communities within the Social Area of Influence
- Figure 5.5-1: Location of Other Project Beneficiaries
- Figure 6.1-1: Environmental and Social Risk and Impact Assessment – Screening and Refinement of Significant Risks and Impacts and Linkage to ESMS Continuous Improvement Process
- Figure 7.3-1: ESMS Document Hierarchy
- Figure 9.2-1: TMA and MWP Discharge and Monitoring Points
- Figure 9.3-1: TMA Groundwater Infiltration Model: Plan View of Major Project Features
- Figure 9.3-2: Comparison of Horizontal Extent of Fe Contamination (mg/L) in Groundwater beneath TMA, Year 2 and Year 18
- Figure 9.3-3: Location of Sectional Model Views, Vertical Extent of Fe Concentrations (mg/L) in Groundwater at TMA
- Figure 9.3-4: Comparison of Vertical Extent of Fe Concentrations (mg/L) in Groundwater beneath TMA, Year 2 and Year 18
- Figure 9.3-5: Predicated Discharge Concentrations (mg/L) of TMA Effluent Constituents at Spillway, Operations and Closure/Post-closure Phases
- Figure 9.3-6: CN_F Distribution in TMA Diversion Pond 2 in Years 1, 2, 13, and 22
- Figure 9.3-7: TSS Distribution in TMA Diversion Pond 2 in Years 1, 2, 13, and 22
- Figure 9.3-8: Predicated Discharge Concentrations (mg/L) of MWP Effluent Constituents at Spillway, Operations and Closure/Post-closure Phases
- Figure 9.3-9: As Distribution at MWP Spillway in Years 1, 2, 13, and 22
- Figure 9.3-10: TSS Distribution at MWP Spillway in Years 1, 2, 13, and 22
- Figure 9.3-11: Comparison of Horizontal Extent of As Concentrations (mg/L) in Groundwater beneath MWP, Year 2 and Year 18
- Figure 9.3-12: Location of Sectional Model Views, Vertical Extent of As Concentrations (mg/L) in Groundwater beneath MWP
- Figure 9.3-13: Comparison of Vertical Extent of As Concentrations (mg/L) in Groundwater beneath TMA, Year 2 and Year 18
- Figure 9.3-14: Typical Stainless Steel ISO Delivery/Mixing Container
- Figure 10.2-1: Aurora Gold Project AOI – Aurora Site to Buckhall
- Figure 10.3-1: Typical Stainless Steel ISO Delivery/Mixing Container
- Figure 11.2-1: Project Concession (A1 Mining License) Boundary in Relation to Environmental AOI

List of Images

- Image 4-1: Cuyuni River and a tributary (lower center part of photograph) showing a small-scale mining operation with visibly high suspended sediment loads in the tributary and the margins of the river, April 2009. Source: Langstroth, 2009
- Image 4.8-1: Cuyuni River and a tributary (lower center part of photograph) showing a small-scale mining operation with visibly high suspended sediment loads in the tributary and the margins of the river, April 2009. Source: Langstroth, 2009
- Image 4.8-1: Barama Road and associated small-scale mining activity to north of the Cuyuni River, March 2009. Source: Langstroth, 2009
- Image 4.8-2: Secondary vegetation in Golden Mile area of the Aurora concession, March 2009. Source: Langstroth, 2009
- Image 4.8-3: Cuyuni floodplain forest with *Mora excelsa* trees, Aurora concession, March 2009. Source: Langstroth, 2009
- Image 4.8-4: Ridgetop forest in Aurora concession, March 2009. Source: Langstroth, 2009
- Image 4.8-5: *Hoplias malabaricus* (haimara) caught by small-scale miners at camp near Alligator Creek in a concession not owned by GGI outside of the Aurora concession, April 2009. Source: Langstroth, 2009
- Image 4.8-6: Fine sediment along lower reach of Alligator Creek, affected by upstream ASM activity, April 2009. Source: Langstroth, 2009
- Image 4.8-7: *Allobates femoralis*, an abundant forest floor frog in the Aurora concession, April 2009. Source: Langstroth, 2009
- Image 4.8-8: *Anolis planiceps*, a common forest floor lizard in the Aurora concession, April 2009. Source: Langstroth, 2009
- Image 4.8-9: Guiana red howler monkeys (*Alouatta macconnelli*) along Cuyuni River across from Aurora concession, May 2009. Source: Langstroth, 2009
- Image 4.8-10: *Rhaebo nasicus* toad at Aurora concession, May 2009

List of Appendices

- Appendix 2A: Aurora Gold Project – Selected Preliminary Design Drawings
- Appendix 4A: Bio-Assessment of the Cuyuni River near Aurora, Guyana, Environmental and Economic Implications, October 2009
- Appendix 4B: CBD Review of Aurora Project Biodiversity Baseline Studies
- Appendix 5A: Example of Questionnaire Used for Gathering Updated Social Baseline Data
- Appendix 5B: Notes from Public Consultation and Information Disclosure Site Visits, 2012
- Appendix 7A: Environmental and Social Management System Plan (ENVIRON)

Appendix 7B: Management Plans (ENVIRON)
Appendix 7C: Standard Operating Procedures (ENVIRON)
Appendix 9A: Geochemical Testing Reports (KCB)
Appendix 9B: Hydrogeology/Groundwater Inflow Study (ITASCA)
Appendix 9C: Water Quality Study Report (ENVIRON)
Appendix 9D: Report from Independent Review of TMA Design
Appendix 14A: Archaeological Baseline Study Report

Approved by: ENVIRON International Corp



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July 30, 2013

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Acronyms and Abbreviations

µg/g	microgram(s) per gram
3D	three-dimensional
ABA	acid-base accounting
AES	audio encounter survey
AG	acid generating
ANFO	ammonium nitrate – fuel oil
AOI	Area of Influence
APA	Amerindian People's Association
APELL	(UNEP) Awareness and Preparedness for Emergencies at Local Level
API	American Petroleum Institute
ARD	acid rock drainage
ASM	artisanal and small-scale mining
ATV	all-terrain vehicles
CaNP	Carbonate Neutralization Potential
CEO	Chief Executive Officer
CI	Conservation International
CIL	Carbon in Leach
cm	centimeters
cm/s	centimeters per second
CN	(sodium) cyanide
CN _F	free cyanide
CN _T	total cyanide
CN _{WAD}	weak acid dissociable cyanide
CND	cyanide destruct
CPAR	Corrective/Preventive Action Request
CR	Critically Endangered (as listed by IUCN Red List of Threatened Species)
CSBD	(University of Guyana) Centre for the Study of Biological Diversity
CSW	commercial sex workers
DAI	Direct Area of Influence
DMRCP	Detailed Mine Reclamation and Closure Plan
E/EWC	exploration/early works construction
EAB	Environmental Assessment Board
EHS	environmental, health, and safety
EN	Endangered (as listed by IUCN Red List of Threatened Species)
ENVIRON	ENVIRON International Corporation
EPA	Environmental Protection Agency
EPC	engineering, procurement, and construction
ERM	Environmental Resource Management (Group, Inc.)
ESAR	Environmental and Social Aspects Register
ESHS	Environmental, Social, Health, and Safety
ESIA	Environmental and Social Impact Assessment
ESIP	Environmental and Social Implementation Plan
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System

ETZ	Equatorial Trough Zone
FPIC	Free, Prior, and Informed Consent
FWP	Fresh Water Pond
GCAA	Guyana Civil Aviation Authority
GDP	gross domestic product
GFC	Guyana Forestry Commission
GGI	Guyana Goldfields, Inc.
GGMC	Guyana Geology and Mines Commission
GHG	greenhouse gas
GIIPs	Good International Industry Practices
GMFE	Guianan Moist Forests Ecoregion
GPF	Guyana Police Force
GPS	global positioning system
GSEC	Ground Structures Engineering & Construction, Ltd.
GSI	Guiana Shield Initiative
ha	hectares
ha/yr	hectares per year
HCN	hydrogen cyanide
HDI	Human Development Index
HDPE	high-density polyethylene
HFO	heavy fuel oil
HR	human relations
HSE	health, safety, and environmental
IAI	Indirect Area of Influence
IBA	Important Bird Areas
ICMC	International Cyanide Management Code
ICMI	International Cyanide Management Institute
IFC	International Finance Corporation
ILO	International Labor Organization
ISO	International Organization for Standardization
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter Tropical Convergence Zone
IUCN	International Union for Conservation of Nature
kg	kilogram(s)
kg/d	kilogram(s) per day
km	kilometer(s)
km ²	square kilometer(s)
LC	Least Concern (as listed by IUCN Red List of Threatened Species)
LOM	Life of Mine
LPG	liquefied petroleum gas
m	meter
M	million
m ³ /d	cubic meters per day
m ³ /s	cubic meters per second
MA	Mineral Agreement
masl	meters above sea level

mbsl	meter(s) below sea level
MCE	maximum credible earthquake
mg/g	milligram per gram
mg/L	milligrams per liter
ML	mining license
mm	millimeters
MOAA	Ministry of Amerindian Affairs
m/s	meters per second
MS-NP	Modified Sobek-Neutralization Potential
Mt/a	Million tonnes per annum
MW	megawatt
MWH	Montgomery Watson Harza
MWP	Mine Water Pond
NAG	Net-Acid Generating
NGO	nongovernment organization
NI	National instrument
N-PAG	Not-Potentially Acid Generating
NT	Near Threatened (as listed by IUCN Red List of Threatened Species)
NTU	Nephelometric Turbidity Units
OHS	occupational health and safety
PAG	Potentially Acid Generating
PDAC	Prospectors & Developers Association of Canada
PL	prospecting license
PMF	probable maximum flood
PO	purchase order
PS	(IFC) Performance Standard
PVC	polyvinyl chloride
RBA	Rapid Biodiversity Assessment
RCRA	Resource Conservation and Recovery Act
ROM	Run of Mine
ROW	right of way
SDI	Simpson's Index of Diversity
SEDAR	System for Electronic Document Analysis and Retrieval
SFE	Shake Flask Extractions
SGS	SGS Mineral Services
SLR	sublevel retreat
SOP	standard operating procedure
STD	sexually transmitted diseases
TBD	to be determined
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TMA	Tailings Management Area
TOC	table of contents
tpd	tonnes per day
TSS	total suspended solids
UN	United Nations

UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
US	United States
USEPA	United States Environmental Protection Agency
UV	ultraviolet
VES	Visual encounter survey
VP	Vice President
VU	Vulnerable (as listed by IUCN Red List of Threatened Species)
WAD	weak acid dissociable
WHO	World Health Organization
WWF	World Wildlife Fund
µS/cm	micro Siemens per centimeter

Executive Summary

Executive Summary

1. Introduction

Guyana Goldfields, Inc. (GGI) is developing the Aurora Gold Project (Project) in a remote, forested, and largely uninhabited area of northwestern Guyana. GGI acquired 100% interest in the Project in 1998, and since that time has conducted surface and subsurface investigations to characterize the geology and grade of the mineral resource, as well as a wide range of associated environmental and social baseline and impact assessment studies. GGI has summarized the technical and economic feasibility of the Project in several studies conforming to Canadian National Instrument (NI) 43-101. These are publically available on the System for Electronic Document Analysis and Retrieval (SEDAR) website, and include:

- “Aurora Gold Project - Guyana, South America, NI 43-101, Technical Report on Updated Preliminary Assessment” (AMEC, 2009);
- “NI 43-101 Technical Report, Feasibility Study, Aurora Gold Project, Guyana” (SRK, 2012); and
- “NI 43-101 Technical Report, Updated Feasibility Study, Aurora Gold Project, Guyana, South America” (TetraTech, 2013).

The (TetraTech, 2013) study defines a consolidated mine design with significantly reduced power requirements and a 40% smaller overall environmental footprint, and forms the conceptual basis for the final design of the Project.

The Project has obtained all environmental permits required by the Republic of Guyana prior to initiating the major construction phase of the Project. GGI has also committed to the establishment of environmental and social practices for the Project that comply with the legal requirements established by the nation of Guyana as well as:

- applicable International Finance Corporation (IFC) Performance Standards (IFC, 2012);
- IFC “Environmental, Health, and Safety General Guidelines” (IFC, 2007a);
- IFC “Environmental, Health, and Safety Guidelines for Mining” (IFC, 2007b);
- the International Cyanide Management Code (ICMC); and
- other applicable Good International Industry Practices (GIIPs).

In keeping with the requirements of the IFC Performance Standards (PSs), GGI has also undertaken multiple studies in recent years to assess the environmental and social risks and impacts of the Project and develop appropriate avoidance and mitigative measures. An initial environmental and social impact assessment (ESIA) was conducted by Environmental Resources Management, Inc. (ERM) in 2010. GGI commissioned ENVIRON International Corp (ENVIRON) to prepare this updated ESIA, building on the (ERM, 2010) version and incorporating comments provided by IFC, the January 2012 updates to the IFC PSs, and the project design changes reflected in the latest NI 43-101 report (TetraTech, 2013). This updated ESIA is supported by a fully documented Environmental and Management System (ESMS), prepared in accordance with current PS 1 requirements and describing the various mitigation

measures, management plans, and standard operating procedures (SOPs) that will be implemented to address the Project's anticipated environmental and social risks and negative impacts, over the entire Project life-cycle. ESMS documentation is provided for reference in **Appendices 7A, 7B, and 7C** of the updated ESIA.

The following paragraphs summarize the findings of the updated ESIA. It should be noted that Sections 7 through 15 specifically discuss the applicability of the eight IFC PSs (IFC, 2012) to the Project and the findings under each applicable PS.

2. Project Description

The Project is located in a remote, forested, and largely uninhabited area of northwestern Guyana as noted in **Figures ES-2.0-1 and 2.0-2**, and is comprised of four major components:

- the **Aurora mine site**, located on the south bank of the Cuyuni River at latitude 6°45'N, longitude 59°45'W, within the boundaries of an approved 5,802 ha A1 Mining License;
- the **Buckhall** logistics support facility, on the west bank of the Essequibo River;
- the **Barama (M3) road**, built in the 1990s to provide access to a large hardwood timber concession north of the Cuyuni River owned by Barama Company Ltd., and for which GGI has negotiated a shared usage arrangement; and
- the **Aurora (M3) road extension**, a new 33 km road constructed by GGI in 2011-2012 connecting the Barama road to Tapir Crossing (a vehicle barge ferry landing on the Cuyuni River), and extending due west to the Aurora mine site.

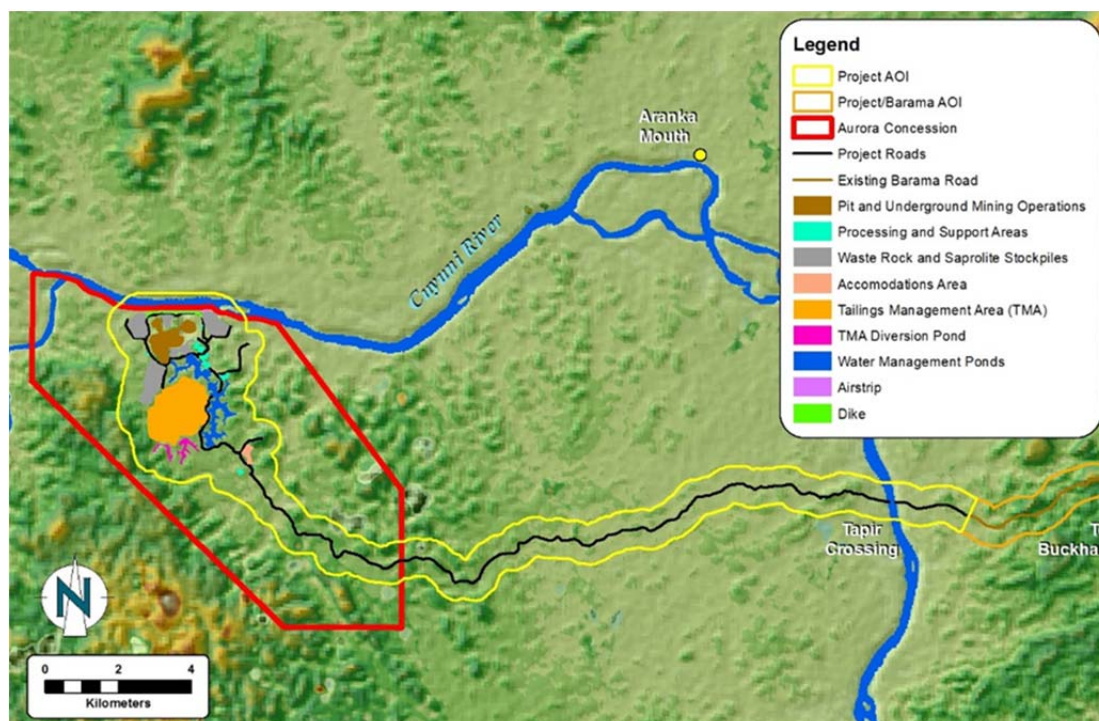
The greatest concentration of mineral resources at the Aurora site occurs within an approximately 2 km long corridor within GGI's A1 Mining License area. The Project is located in the Guiana Shield, a palaeo-Proterozoic granite-greenstone terrane considered to be the extension of the West African palaeo-Proterozoic Birimian Supergroup terrane, which hosts a number of significant gold mining properties (e.g., present-day southern Ghana). Mineral resources in the Project's Mining License area are reported at two cut-off grades in (TetraTech, 2013) to reflect the fact that certain zones of gold mineralization are more suitable for open pit extraction methods, while others are generally of higher grade and therefore more amenable to underground mining methods.

Environmental studies indicate that the forested areas in the area of the Project have been significantly impacted by artisanal and small-scale mining (ASM), logging, hunting, and other intrusive human activities for well over a century. The area immediately surrounding the Aurora site was first explored in the 1930s and 1940s and has been impacted by ASM activities ever since. Large faunal species otherwise common along similar types of rivers in this part of South America are absent or very rare, which is interpreted as a key indicator of historical human impact, presumably due to the pressures of hunting and the increased turbidity and general degradation of river quality from many years of logging and ASM activities.

Figure ES-2.0-1: Aurora Gold Project Location [Source: (TetraTech, 2013)]



Figure ES-2.0-2: Project Layout, Concession Boundary, and Environmental AOI



There are no communities in the immediate area of the Project's A1 Mining License or environmental area of influence (AOI), and the Project's environmental AOI does not encroach on any titled Amerindian lands. However, two informal communities are considered to be within the Project's direct (social) AOI; these are:

- **Aranka Mouth**, an informal settlement engaged primarily in commerce with the ASM in the area, located on the north bank of the Cuyuni River approximately 16 km downstream from the Aurora site, and
- **Buckhall**, an informal community at the eastern end of the Barama (M3) road, adjacent to GGI's logistics support facility of the same name and the Barama headquarters, milling and export facility immediately to the north. The Buckhall community is due south of the Barama Company Ltd. operations center; its residents are engaged primarily in logging, ASM, and light commerce.

Although remote and heavily forested, the general area of the Project has been traversed or investigated by groups or individuals engaged in ASM, hunting, and other intrusive human activities for many years. However, no legal or illegal ASM operations have been or will be displaced by Project activities. GGI's actions in securing its Mining License have been conducted in accordance with all applicable Guyanese legal requirements. In addition, the Government of Guyana has, through the granting of the Project's Environmental Permit (Guyana EPA, 2010), required GGI to systematically discourage influx to the Project area, in order to minimize the potential for generation of negative environmental and social risks and impacts. However, with the high price of gold, the ASM sector is extremely active in the Project region.

Depending on the phase of the project, the Project will employ from 200 to 475 personnel, approximately 90% of whom will be Guyanese nationals. Activities anticipated in the major phases of the project include:

- **Preconstruction phase:** completion of a new, modern man-camp, clearance activities for major earthworks and the open pit area of the mine, completion of local access roads, and erosional stabilization of all access road rights of way (ROWS);
- **Major construction phase:** construction of crushing, milling, mineral separation, and cyanide detoxification plant infrastructure; construction of the tailings and reclaim water pipelines; construction of the first raise of the Tailings Management Area (TMA), Fresh Water Pond (FWP), and Mine Water Pond (MWP); decommissioning and reclamation of a temporary man-camp at Tapir Crossing; completion of the wharf and supporting facilities at Buckhall; installation of electrical power generation equipment, wastewater treatment systems, explosives magazines, fuel storage and fuelling areas, and sanitary landfills; prestripping of the pad for the first waste rock stockpile; construction of two protective dikes between the Cuyuni River and the pit mining areas; and renovation of the Aurora site airstrip;

- Operations Phase:** because of its low strip ratio, the Rory's Knoll open pit area will be mined first. Near-surface saprolite and fresh rock ore deposits will be mined and access developed to the underground deposits as early in the operational phase as possible. Mining operations will be conducted around the clock, 365 days per year. Blasting operations are expected to be conducted by a specialty contractor who will manage all required permitting, explosives transport, installation and operation of blasting magazines and blasting agent silos, and downhole delivery services. Open pit mine design is based on a conventional surface mine operation using 152 mm blast holes, front end loaders for ore and waste loading, and haulage by a fleet of 43.5 tonne capacity trucks. The ultimate pit design incorporates pit slope geometries for the various rock types and pit sectors, includes haulage ramps, and takes into account minimum mining widths based on the mining equipment selected. Mining of the Aleck Hill, Aleck Hill North, Mad Kiss, and Walcott Hill pits is planned to occur generally in parallel after the Rory's Knoll pit has reached its design depth and underground operations are under way (approximately 8 years after the start of open pit mining).

Construction of the underground mine portal and advancement of a spiral access decline and accompanying ventilation/emergency egress raises will begin approximately two years prior to the end of open pit operations, in order to ensure a consistent ore source for mill processing. The mine is designed to exploit the Rory's Knoll deposit from about 75 meters below sea level (mbsl) to approximately 970 mbsl; the mine portal will be constructed on the southern edge of the run-of mine (ROM) ore stockpile pad at about 75 meters above sea level (masl). The mine is designed to use a combination of open benching (for the first six sublevels) followed by the sublevel retreat (SLR) mining method for all remaining sublevels. Studies indicate that SLR methods represent the lowest cost option with manageable risks, maintenance of a safe mining environment, and achievement of desired production rates. They also eliminate any need for paste backfill (which would require diversion of tailings and significant infrastructure).

Ore will be crushed to a millable size in three stages. The mill and mineral separation facility is designed to treat a nominal 1.75 Mt/a increasing to 3.5 Mt/a in later phases of operation. All ore types are amenable to conventional cyanide leaching using a modified carbon in leach (CIL) circuit for leaching followed by carbon desorption and separation of doré bullion via electrowinning. Process tailings will be treated using an air/SO₂ cyanide detoxification system, operated to achieve a nominal weak acid dissociable (WAD) cyanide concentration of 0.5 mg/l in the tailing stream as it enters the tailings pipeline and is deposited in the TMA, which corresponds to the actual environmental discharge limit established for such facilities by (IFC, 2007a) and the ICMC. The TMA will have a two-level spillway, which will be raised along with each dam raise.

The site receives over 2 meters of rainfall annually, and initial site water balance modeling results indicate a strongly positive water balance that will require periodic controlled discharges to the environment. The TMA has therefore been designed to provide a minimum retention time of 30 days for all accumulated runoff and tailings supernatant prior to any potential discharge, assuming mean annual precipitation conditions. Over the first four years of operation, the mixing ratio for tailings water and

precipitation within the TMA capture area is estimated to be 1:9 during an average year. Any water discharged from the TMA spillway will flow into a pond for additional dilution prior to entering the environment. If necessary, additional sedimentation or polishing ponds will be installed to provide additional dilution or treatment capability.

- **Decommissioning, Reclamation, and Closure Phase:** mining operations will cease approximately 18 years after the start of open pit mining operations, although the actual length of mine life will be determined by actual recoveries, commodity price performance, and other factors. When mining ceases, the final stockpile of ROM ore will be processed, and the Project will enter a period of decommissioning and closure. GGI has developed a conceptual *Mine Reclamation and Closure Plan* which will be issued and implemented within the context of the Project ESMS, and periodically updated over the life of the mine. In addition to predicted final closure actions, the *Mine Reclamation and Closure Plan* (full text of which is included in **Appendix 7B** of the updated ESIA) addresses progressive and interim closure actions; specific actions to minimize the attractiveness of the closed site for any future ASM incursions; workforce retrenchment considerations; and post-closure inspection and monitoring. Two years prior to the anticipated end of mine life, a detailed version of this document (the *Detailed Mine Reclamation and Closure Plan*) will be prepared and submitted to the Guyana Environmental Protection Agency (Guyana EPA) for review and approval. Ownership of the Project airstrip, the Aurora (M3) road extension to the end of the Barama road, the ferry landings at Tapir Crossing, and the Buckhall river port and logistics center is expected to revert to the Government of Guyana, as required under the Guyanese regulatory framework, at the end of mine life, and these features will therefore not be decommissioned.
- **Post-Closure Phase:** a nominal 2-year post-closure period was defined in (TetraTech, 2013) and is reflected in the initial closure cost estimate included in the first iteration of the Project *Mine Reclamation and Closure Plan*. In actual practice, the predicted length of the post-closure monitoring period will be periodically examined, refined in annual reviews of the *Mine Reclamation and Closure Plan* as GGI gains experience with actual progressive closure actions and develops associated monitoring data that can be used to assess the effectiveness of selected reclamation, revegetation, and erosion prevention strategies over time. It is expected that these data will permit identification of the most successful reclamation, revegetation, and erosion prevention strategies that can be applied in final closure, and that can be effectively monitored during post-closure. The final *Detailed Mine Reclamation and Closure Plan* submitted to the Guyana EPA may include additional negotiated or supplemental post-closure monitoring actions or monitoring schedule extensions.

Section 2 of the updated ESIA is supported by **Appendix 2A**, which contains a series of preliminary design drawings that are consistent with the design presented in (TetraTech, 2013) and provide general descriptions of the major infrastructure elements of the Project.

3. Alternatives Assessment

The location of economically recoverable ore has defined the general physical boundaries of proposed open pit and underground mining operations for the Project. GGI explored several options for the location and design of the project's supporting infrastructure, in a series of feasibility studies conducted from 2009 through 2012. In late 2012 and early 2013, GGI conducted an additional study (TetraTech, 2013) that generated a number of design alternatives that reduced the overall environmental footprint of the Project by 40% (from approximately 2,000 hectares to 1,200 hectares), while at the same time improving Project economics. These design changes also ensured that all Project components have been located within the boundaries of GGI's current Mining License, as noted in **Figure 1.0-2**.

4. Environmental Baseline

Section 4 of the updated ESIA contains the results of studies that update the environmental baseline in the area of the Project's environmental AOI; see **Figure ES-2.0-2**. These studies were designed to build on the information presented in (ERM, 2010) version of the ESIA and introduce new information gained in public consultations, in discussions with leaders of independent field studies, and other new field studies conducted for GGI in 2011 and 2012. As recommended by IFC, additional information was developed to identify priority biodiversity features in the AOI for assessment of habitat characteristics and for future monitoring of mitigation measures. These updated studies also considered independent review comments provided by the University of Guyana Centre for the Study of Biological Diversity (CBSD, 2013).

Results of the updated environmental baseline studies confirm that the forest-river systems of the Cuyuni basin are integrated through surface water and groundwater-based hydrological processes, and the forests are important for the maintenance of hydrology and water quality. The natural surface waters of the region are generally considered "blackwaters," with low pH, high contents of tannins and organic acids, and low suspended solids. However, in the Cuyuni basin, this natural condition has been substantially altered by human impacts. ASM has been identified as the leading cause of deforestation in Guyana, estimated at approximately 94% of total (Guyana Forestry Commission, 2012). ASM activities date back over a hundred years and have been (and continue to be) primarily surface alluvial mining along tributary creeks to the Cuyuni. Dredging of the river bed sediments is also a popular ASM method, however, and has led to a very significant increase in turbidity and sedimentation in the river. The use of mercury in the gold amalgamation process and its release to the environment is another major regional environmental concern. Depletion of fauna in and near the Cuyuni River has also been well documented in studies such as (Duplaix, 2009), full text of which is included as **Appendix 4A** in the updated ESIA. Significant loss of diversity and depletion of abundance in fish species in the Cuyuni River and its tributaries due to the turbidity and other water quality issues resulting from current and historical ASM has also been independently observed both upstream and downstream from the Project's Mining License area.

5. Socio-Economic Baseline

Section 5 of the updated ESIA is based on socio-economic baseline information originally presented in the (ERM, 2010) version of the ESIA, supplemented by new data and information gained from additional public consultations in 2011 and 2012. These studies confirm that in the

vicinity of the Project AOI, the dominant population consists of small-scale gold miners and an associated informal service community which has developed in proximity to the main mining areas. The Project's environmental AOI does not encroach on any titled Amerindian lands or lands frequented by Amerindians; the Amerindian community nearest to the Project's Mining License is approximately 40 km upstream on the Cuyuni River to the west of the rapids at Devil's Hole.

The social fabric of the region and the Project AOI is dynamic and has been changing rapidly in recent years as the price of gold has increased. ASM has been a regionally important economic activity for a century or more, but the ASM population was not included in the government's 2002 census, and no reliable population data are available. Additionally, as much of the gold is sold through the black market, there are no reliable statistics on the economic value of ASM. Tracking the populations of miners and the amount of gold taken and sold is extremely difficult due to the remoteness of the area and the influence that the price of gold exerts on the numbers of individuals actually engaged in ASM. ASM camps are largely temporary and mobile, concentrated along tributaries to the Cuyuni. With the consistently high price of gold in recent years, there has been a significant increase in the numbers of miners, and the areas of impact have visibly increased, based largely on aerial observations. Gold prices have incentivized residents of Guyana's coastal areas and Brazilian and other foreign nationals to migrate to interior areas rich in alluvial gold, in search of economic opportunities.

Public consultations conducted in 2011 and 2012 confirmed that there are no formal or informal communities in the immediate area of the Project's A1 Mining License or environmental AOI. Two informal communities are considered to be in the Project's direct (social) area of influence, however; these are:

- **Aranka Mouth**, an informal settlement engaged primarily in commerce with ASM, located on the Cuyuni River approximately 16 km downstream from the Aurora site, and approximately 10 km due north of the Aurora (M3) road extension; and
- **Buckhall**, an informal community at the eastern end of the Barama (M3) road, adjacent to GGI's secure logistics support facility of the same name and the Barama headquarters, milling and export facility immediately to the north. The Buckhall community is on the western bank of the Essequibo River, due south of the Barama Company Ltd. timber operations center, with residents engaged primarily in logging, ASM, and light commerce.

No legal or illegal ASM operations have been or will be displaced by Project activities. In addition, it should be noted that the Government of Guyana requires GGI to systematically discourage influx to the Project area, in order to minimize the potential for the generation of negative environmental and social impacts. GGI has addressed this requirement in the preparation of the Project *Influx Management Plan* and *Community Relations Management Plan*, copies of which are included for reference in the updated ESIA in **Appendix 7B**, as well as its environmental and social grievance procedures, which are appended to the Project *ESMS Plan* in **Appendix 7A**.

The discussion of updated socio-economic baseline studies in Section 5 of the updated ESIA is also supported by:

- **Appendix 5A**, which provides an example of the questionnaires used to gather data for the updated social baseline study; and
- **Appendix 5B**, which presents examples of the public meeting notices, posters, notes, and contact records from an additional round of public meetings conducted by GGI in 2012 specifically to engage the communities of Buckhall and Aranka Mouth.

6. Risk and Impact Assessment

Section 6 of the updated ASIA builds on the presentation and assessment of environmental and social impacts originally conducted in (ERM, 2010) and updated in (TetraTech, 2013). An assessment of known or potential risks and impacts within the project's environmental and social AOI (and the associated significance of any negative impacts) has been conducted and documented in tabular format. The assessment addressed discrete impacts directly associated with anticipated Project operations as well as other impacts, originating with or affected by historical ASM activities in the Project AOI, that have incremental, cumulative, or residual characteristics. The relative significance of all identified impacts was determined through a uniform process, i.e., semi-quantitative estimation of:

- the relative *scale, severity, frequency, and duration* of the impact;
- GGI's *ability to influence* the relative scale, severity, frequency, and duration of the impact; and
- the *potential for a negative public perception* to be generated due to the impact.

Numerical rankings were added and the sum multiplied by a simple probability ("likelihood of occurrence") factor to yield final significance values, which have been considered in the development of appropriate impact avoidance and/or mitigation strategies. Preliminary results from this estimation process (which will be iterated over the life of the mine as part of the continual improvement processes established by the Project ESMS) indicate that the most significant environmental and social challenges of the Project will include:

- management of erosion and maintenance of geotechnical stability in all dikes, dams, embankments, stockpiles, and other major earthworks constructed at the Aurora site;
- management of tailings effluent, waste rock stockpile and road ROW runoff, pit runoff/underground mine water, and landfill leachate, in order to ensure that residual impacts from historical ASM within the Project AOI are not exacerbated by Project operations, and mitigated as necessary to ensure that runoff/effluent quality meets or exceeds requirements established by the governing Environmental Permit, the requirements of (IFC, 2007a), and the requirements of the ICMC;

- management of opportunistic influx at the Aurora and Buckhall sites, associated with employment seekers, perceived ASM opportunities, and vendors seeking to exploit legal and illegal commercial opportunities with the Project workforce;
- management and mitigation of the transportation-related environmental and social risks and impacts associated with the long-term delivery of machinery, equipment, fuel, reagents, and other consumables to the Project over the Barama/Aurora (M3) extension road;
- long-term management of the potential spills of fuel or hazardous chemicals at the Aurora site and the Buckhall logistics support facility; and
- long-term management of non-hazardous and hazardous wastes generated at the Aurora site and the Buckhall logistics support facility.

The results of this initial assessment prompted the development of an initial suite of management plans and SOPs to avoid, minimize, manage and mitigate risks and impacts likely to occur as the Project transitions to major construction. These documents are included for reference in **Appendices 7B and 7C** of the updated ESIA. The initial assessment results will also be subject to the development of additional performance improvement actions pursuant to the requirements of the Project *ESMS Plan*, included in **Appendix 7A**.

7. Assessment and Management of Environmental and Social Risks and Impacts (Ref: IFC PS 1)

As GGI has committed to compliance with (IFC, 2012) requirements, IFC PS 1 is applicable to the Project. The updated ESIA and Section 6 in particular present a detailed evaluation of the potential environmental and social risks and impacts of the Project. Section 7 (and **Appendices 7A, 7B, and 7C**) of the ESIA presents the overall design and contents of an ESMS that will be implemented to ensure the risks and impacts so identified are properly managed and mitigated, over the entire mine life cycle. The Project *ESMS Plan* is based specifically on the requirements of PS 1; it also incorporates applicable elements of:

- relevant IFC Environmental, Health, and Safety (EHS) Guidelines (i.e., General EHS guidelines plus the Industry Sector Guidelines for Mining and Toll Roads)¹ and other IFC guidance documents and GIIPs as referenced therein;
- the ISO 14001 environmental management system standard (International Organization for Standardization, 2004); and

¹ See http://www1.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/IFC+Sustainability/Sustainability+Framework/Environmental,+Health,+and+Safety+Guidelines/

- the OHSAS 18001 occupational health and safety (OHS) management system standard (OHSAS, 2007).

These standards have been widely and successfully applied by the international mining industry and collectively provide an appropriate basis for the development of an effective, fully integrated ESMS capable of addressing applicable Guyanese regulatory requirements as well as PS 1 and other GIIPs for the management of the environmental, OHS, and other social aspects of mining project operations.

The *ESMS Plan* will be supported by a suite of management plans, which will be focused on the avoidance, minimization, management and/or mitigation of the specific environmental and social risks and impacts generally associated with one or more phases of the Project. A list of the management plans likely to be required over all phases of the Project and their general applicability during each phase is included in the *ESMS Plan*. Conceptual drafts of 14 of these documents were developed to support the Project as it transitions from the exploration/early works construction phase to the major construction phase, and are provided for reference in **Appendix 7B** of the updated ESIA.

SOPs will be written specifically to guide GGI workers and (when invoked by contract) contractor personnel in the day-to-day performance of specific activities required by the ESMS Plan or upper-tier management plans. SOPs will be developed with a level of detail commensurate with the phase of the project, the complexity of the task, current staffing levels, and the capabilities and experience of the workforce, and may support one or several management plans and one or several Project phases. An initial suite of 44 SOPs is included for reference in **Appendix 7C** of the updated ESIA.

8. Labor and Working Conditions (Ref: IFC PS 2)

IFC PS 2 also applies to the Project, and Section 8 of the updated ESIA summarizes the approach used by GGI to achieve compliance with IFC labor and working condition requirements on the part of its workforce and supply chain. GGI has established the *Guyana Goldfields, Inc. Human Resource Policy* and *Environmental, Health, and Safety Policy Statement – Aurora Projects*, both of which are documents managed as elements of the Project *ESMS Plan*; see **Appendix 7A**. As noted therein, these documents specifically prohibit discrimination in hiring practices, sexual harassment or intimidation in any form, and permit workers to form and join organizations of their own choosing and to bargain collectively. The policies contain a specific commitment to comply with all applicable laws and regulations, and to comply with PS 2 requirements in particular. Periodic, systematic verification of Project performance with these compliance commitments is also a key element of the ESMS. Collectively, the policy documents underscore a fundamental commitment on GGI's part to protecting the health, safety, and wellbeing of the Project workforce. A commitment to mutual respect and open communication is also emphasized and is reflected in the expectations for workforce behavior and communication outlined in the GGI "Labour Grievance Procedure", which has been separately reviewed and approved by IFC.

GGI's *Human Resources Policy* specifically prohibits forced or child labor, and it is understood that these conditions and a minimum hiring age of 18 are extended to all contractors. Detection of any forced or child labor issues on the part of any GGI supplier or contractor is considered grounds for contract termination.

Other administrative policies and procedures that support the establishment of appropriate labor and working conditions have been established by GGI's Human Relations department. GGI has also developed a Project-specific *Occupational Health and Safety/Accident Prevention Plan* and a comprehensive suite of OHS SOPs; see **Appendices 7B and 7C**.

Guyanese law also requires severance or redundancy payments to be paid when employees are terminated in general layoff scenarios such as the end of mining operations. GGI employees will be entitled to an appropriate severance package in such circumstances. The funding necessary to provide these benefits is recognized as an element of the Project's *Mine Reclamation and Closure Plan* (see **Appendix 7B**) and has been included in the initial decommissioning and closure cost estimate provided therein.

As of the submittal date of this updated ESIA, GGI does not anticipate any engagement of workers through third parties. Should requirements for contract employment services appear over the course of the project, contracts for these services would invoke GGI's "Labour Grievance Procedure" as well as other selected *ESMS Plan* or other ESMS policy, management plan, and/or or SOP requirements, as appropriate for the proposed scope of work.

9. Resource Efficiency and Pollution Prevention (Ref: IFC PS 3)

IFC PS 3 applies to the design, construction, operation, and decommissioning and closure of the Project. Section 9 addresses the Project's approach to the management of water, power, and other resources, and addresses the prevention, minimization, and management of pollution sources associated with key Project components. The Project will out of necessity consume energy, fuel, water, lubricants, tires, steel, and other consumables on an ongoing basis over the life of the mine. However, the Project's consumption of resources is subject to the general economic constraints of a changeable commodity market, as well as:

- environmental and social policy commitments with a strong sustainable development focus;
- commitments to comply with the IFC PSs, EHS guidelines, the ICMC, and other GIIPs;
- the requirements of a Project-specific ESMS based specifically on the type of continuous improvement methodologies referred to in PS 3.

Collectively, these factors will serve to prompt GGI to continually seek operational efficiencies and increased cost-effectiveness in its mining operations, and over time will be reflected in the overall minimization of resource use and increased effectiveness of specific pollution prevention and mitigation measures. Resource use minimization and efficiency strategies generally applicable to the use of key Project resources will include:

- use of blended No. 4 fuel vs. heavy fuel oil for power generation;
- use of No. 2 diesel fuel as primary transportation fuel;
- consolidation of Project environmental footprint, maximum usage of previously impacted areas, minimization of greenfield clearances, and progressive restoration and rehabilitation of cleared ROWs and other areas;
- routine detoxification of process tailings to ≤ 0.5 mg/L WAD cyanide prior to deposition in the TMA;
- recycling of TMA supernatant as mill and mineral separation plant process makeup water;
- preferential use of rainwater harvesting and treatment for potable uses;
- maintenance of equipment to minimize excessive particulate emissions;
- use of the naturally low conductivities of underlying saprolite as basis for a natural liner system, to be used in the design and construction of the TMA, MWP, and FWP;
- provisions for additional dilution/settling ponds to treat effluent for excessive total suspended solids (TSS) that may occur in TMA and MWP effluents;
- although test work indicated non-acid generating conditions in the greater part of the waste rock which would be generated by the Project, installation of toe drains and, if necessary, settling ponds to manage potential acid rock drainage (ARD) conditions;
- reservation of topsoil and organic materials for progressive reclamation and restoration activities;
- design of cyanidation processes to address ICMC requirements for design and operation;
- implementation of waste segregation and waste management practices, including development of permitted landfills and secure temporary hazardous waste storage areas at the Buckhall and Aurora sites; and
- minimization of the use of pesticides and other hazardous chemicals.

10. Community Health, Safety, and Security (Ref: IFC PS 4)

IFC PS 4 applies to all phases of the Projects, and Section 10 presents the Project's approach to the protection of the health, safety, and security of the two small communities closest to Project facilities as well as the GGI and contractor workforce. The ESMS is focused on potential conventional risks and impacts to the two communities, and no detailed studies of climate change impacts specific to these two communities have been or are known to have been conducted. However, GGI understands the Government of Guyana's interests in the potential effects of climate change, especially as they may relate to the frequency and severity of flooding in low-lying river areas, the availability of drinking water from precipitation collection sources, agricultural productivity, and other potential issues involving human health and well-being. GGI has established a sustainable approach to mine construction, operation, and closure, and has:

- minimized the overall environmental clearance footprint of the Aurora Gold Project over earlier design alternatives, as noted in Section 3;
- implemented revegetation and other erosion control efforts on the ROWs of the newly constructed access road to the Aurora site, in keeping with the requirements of the Project's *Erosion Prevention and Control Plan* (see **Appendix 7B**) and specific IFC recommendations;
- developed a preferred power generation alternative that avoids the use of unblended heavy fuel oil or conventional (dam plus reservoir) hydropower generation methods, both of which could potentially generate substantial greenhouse gas (GHG) emissions;
- developed plans for the progressive restoration/revegetation of waste rock/waste saprolite stockpiles; and
- committed to establishing GHG and reporting procedures as part of the *Air Quality Management Plan*, which is slated to be developed and implemented prior to the operational phase of the Project.

GGI will also seek other means of minimizing GHG emissions, and minimizing or mitigating other environmental and social impacts deriving from Project activities that could contribute to global warming, on a continuing basis over the life of the Project.

Since primary access to the mine site will be via the access road from Buckhall, the community of Aranka Mouth (located 16 km downstream from the Aurora site on the Cuyuni River and approximately 10 km north of the road from Tapir Crossing to the Aurora site) will never be directly impacted by mine traffic. However, the Buckhall community is immediately adjacent to the Project's logistics support facility, certain measures to minimize influx must be observed. Direct interactions between GGI personnel and contractors and the local community will be restricted to employees or contractors whose families may live in or near Buckhall, or to those personnel specifically authorized to organize or conduct periodic formal community relations contacts in accordance with the Project's *Community Relations Management Plan* and *Influx Management Plan*. As a matter of policy, no hiring of employees or purchasing of goods or services will be permitted at Buckhall. Potentially qualified applicants or merchants will be encouraged to apply or make contact through GGI's headquarters office in Georgetown. Interactions with the community will be limited to certain types of legal commerce (e.g., purchasing of a limited range of foodstuffs, personal items, or consumer goods) mutually agreed upon by community residents with the concurrence or approval of any affected governmental agencies. If local residents consider these general rules to be too restrictive in providing appropriate access to employment or opportunities for legitimate commerce, they will have access to the Community and Environmental Grievance Procedure for appropriate redress. No illegal activities on the part of GGI employees or contractors will be permitted, as noted in the Project's Labour Grievance Procedure. More specifically, no interactions involving the purchase or sale of alcohol by GGI or contractor employees will be permitted at Buckhall, as alcohol is not permitted on GGI property, or in GGI or contractor vehicles.

Safety risks to the Buckhall community and to transient groups or individuals engaged in ASM will be managed primarily by physical exclusion from the various industrial hazards associated with Aurora Gold Project operations, and by design and construction of mine infrastructure and support facilities in accordance with current GIIPs for mines of this type. Except in cases of medical or humanitarian emergency, or as may be permitted by an organized community relations outreach action, members of the general public or transient groups or individuals will not be permitted access to major areas or elements of Project infrastructure. In addition, embankments and overall design of the TMA have also been subjected to an independent engineering review to assess the overall adequacy of the conceptual design; the design was determined to be feasible with no fatal flaws noted.² The results of this review are included for reference in **Appendix 9D** of this updated ESIA.

All cyanide management processes and facilities will be designed to specifically incorporate the applicable minimum requirements of the ICMC, including purchasing of cyanide exclusively from an ICMC- certified producer; transportation of cyanide to the Aurora site exclusively by an ICMC-certified transporter; and physical transportation of cyanide reagent to the site as dry briquettes in dedicated stainless steel ISO delivery/mixing containers, which is generally recognized as the most intrinsically robust delivery system where ocean or open water transportation links are involved. Hazards related to the transportation and storage of fuels, explosives, and other chemical reagents will be mitigated by GIIPs for hazardous materials management, secondary containment, spill prevention and response, and fire prevention; a wide range management plans have been or will be developed to aid in this mitigation; see **Appendices 7A, 7B, and 7C**.

Protection of the health of the GGI workforce is vital to the success of the Project, and prevention of the transmission of disease between the GGI workforce and the affected communities is a key health consideration. Exposure to disease will be managed primarily by restricting GGI workforce, contractor, and visitor interactions with the residents of Aranka Mouth and Buckhall, as well as interactions with transient groups or individuals engaged in ASM or other intrusive activities on or near the Aurora site. All GGI workers, contractors, and visitors will be subject to screening for communicable diseases prior to travelling to the Aurora site. SOPs have been established to reinforce relevant aspects of the Code of Conduct in the GGI Labour Grievance Procedure, including strict prohibitions on the use of alcohol and illicit drugs, proper procedures for waste segregation and disposal, minimization of interactions with residents of affected communities, and prohibitions on the harboring of wild animals or plants. Such SOPs also establish basic requirements for personal hygiene, food preparation and handling, recognition of the symptoms of communicable diseases, guidance on the provision of emergency medical care to affected community residents or transient groups or individuals, and specific emergency actions to take place in the event of a suspected disease outbreak.

GGI will not directly engage Republic of Guyana military or police resources for providing routine security services for the Project. GGI has maintained its own security service in Guyana over 10 years, and GGI security personnel have very substantial experience in the management

² This review is understood to be part of an ongoing engagement to provide independent review of the TMA and MWP facilities, which will continue through final design, construction, and operation.

of interactions with individuals or groups involved in ASM or other legal or illegal intrusive human activities in and around the Projects Mining License area. GGI's security service maintains liaison contacts with the nearest Guyana Police Force and Guyana Defense Force outposts in the event that additional security resources may be needed in response to evidence of significant crimes, criminal activities, or other security issues. GGI's site security practices are generally consistent with the practices outlined in the UN "Code of Conduct for Law Enforcement Officials" (UN, 1990 and the UN "Basic Principles on the Use of Force and Firearms by Law Enforcement Officials" (UN, 1979).

11. Land Acquisition and Involuntary Resettlement (Ref IFC PS 5)

IFC PS 5 has been determined to be not applicable to the Project, as there are no permanent communities or residences within the boundaries of the Project's Mining License (see **Figure ES-2.0-2**) or the project's environmental or social AOIs that would require any physical displacement or resettlement actions. Access to the land for the Buckhall logistics support facility was obtained under a 50 year renewable lease with the Guyana Lands and Surveys Commission, and did not require the displacement of any residents, businesses, or any other prior uses of the land by the adjacent village. Land access and usage for the construction of the road extension from the Barama Road to Tapir Crossing, ferry docking facilities at Tapir Crossing, and the road from Tapir Crossing to the Aurora site was granted by permit from the Guyana Ministry of Transportation. Independent legal reviews of the mineral tenure and surface rights of the Project as well as site access and permitting issues have been conducted and confirm the acceptable legal standing of all of these Project aspects.

12. Biodiversity Conservation and Sustainable Natural Resource Management (Ref: IFC PS-6);

PS 6 has been determined to be applicable to the Project. Section 12 of the updated ESIA presents the Project's approach to the protection and conservation of biodiversity, which includes the introduction of practical and achievable offsets to achieve a "no net loss" goal for natural habitat. Within the Project AOI, many habitat areas have been modified by historic exploration activities that date back to the 1930s. Outside of the Project AOI, much habitat (especially riparian and aquatic habitat) has been modified by many decades of ASM activity.

To the extent practicable, the Aurora Gold Project has reused existing modified habitats for the siting of new facilities and proposed mining activities, avoiding and minimizing use of natural habitats wherever possible. GGI will also prohibit the introduction of invasive species in its restoration and reclamation actions.

It should be emphasized that biodiversity studies conducted in the Project AOI do not indicate any critical habitat areas with high biodiversity value. No habitat has been identified that is of significant importance to critically endangered, endangered, endemic, and/or restricted-range species. Similarly, no habitats have been observed that support globally significant concentrations of migratory and/or congregatory species, highly threatened and/or unique ecosystems, and/or any areas associated with key evolutionary processes.

There are no human communities in reasonable proximity to the Aurora site that would be adversely affected by the Project's potential impacts on ecosystem services. At Buckhall, GGI's site relies entirely on rainwater collection and treatment of well water potable uses. Potable water in the adjacent Buckhall community is from rainwater collection or bottled sources, but there is no source connection with Project operations. No groups have identified any unique cultural services associated with either the Buckhall or Aurora areas. The only ecosystem service upon which GGI might be considered to depend is the provisioning of water for industrial uses at the Aurora site, and for firefighting uses at GGI's Buckhall site. However, GGI has no direct management control over or significant influence on the provisioning of water at either location. At Buckhall, firefighting water will be pumped from the Essequibo River on an as-needed basis. At the Aurora site, there will be no direct abstraction of water from the Cuyuni River. Raw water for industrial purposes will be obtained from water wells drilled into the underlying bedrock, collection of surface water from creeks, and rain water harvesting systems. Potable water will be obtained from rain water harvesting and treatment systems. During the operational phase of the project, water will be recycled for industrial purposes to minimize fresh water extraction needs and will be temporarily retained and diluted to manage sedimentation and overall effluent quality within the guidelines established by (IFC, 2007a). However, with over 2 meters annual rainfall, the net water balance for the project will be significantly positive, and the Project design defined by (TetraTech, 2013) assumes that excess water will be continuously discharged to the environment.

13. Indigenous Peoples (Ref: IFC PS-7)

PS 7 has been determined to be not applicable to the Project since there are no affected communities of indigenous peoples (as defined by PS 7) in the Project's direct AOI. According to geographic data provided by the Guyana Lands and Survey Commission, the Project is not located on or is it adjacent to any titled Amerindian lands. In addition, Amerindians do not use lands within the Project's environmental AOI for seasonal or cyclical use, for their livelihoods, or for cultural, ceremonial, or for any spiritual purposes that may define their identity or community. The nearest Amerindian communities are Bethany (approximately 5 km northwest of Buckhall and north of the Barama road), and Kurutuku, which is approximately 40 km west of the Aurora mine site, on the Cuyuni River.

Although the requirements of PS 7 have been determined not to be applicable, GGI has nevertheless undertaken a positive engagement process with communities of indigenous peoples in the region surrounding the Project, as noted in Section 5. This engagement process has included stakeholder analysis and engagement, disclosure of information, consultation, and participation, in a culturally appropriate manner. The Project has also extended the benefits of the Project to indigenous peoples through its hiring practices. These actions have had a positive impact on the affected Amerindian communities, and it is expected as the Project goes forward, other communities will ultimately be contacted with respect to potential employment opportunities. All such interactions will be managed in compliance with the Project's *Community Relations Management Plan* and *Influx Management Plan*.

14. Cultural Heritage (Ref: IFC PS-8)

As previously noted, the Project's AOI has been significantly impacted by ASM, logging, hunting, and other intrusive human activities for well over a hundred years. No historical monuments or buildings exist that meet the cultural heritage definition in PS 8. This is also the case at the Buckhall logistics support facility and the adjacent community, as well as the ROW areas on the access road between Buckhall and the Aurora Project site.

With respect to archaeological and/or natural sites, GGI commissioned a detailed evaluation of the archaeological setting of the project in 2012 by a recognized expert in Guyanese archaeology which indicated that although likely very rare, some potential could exist for certain types of archaeological finds (e.g., pottery sherds or stone implements of potential Amerindian origin) to be encountered in the Project area. The full text of this report is provided for information as **Appendix 14A** of the updated ESIA.

The “archaeological and/or natural sites” aspect of cultural heritage therefore has some limited applicability to the Aurora Gold Project pursuant to PS 8 requirements. In keeping with this determination, GGI developed SOP GG-25, “Chance Archaeological Finds” as part of the Project ESMS. If any such finds are noted, the SOP requires that land disturbance actions be immediately ceased pending evaluation of the find. If confirmed as potentially significant, a report will be submitted to the National Trust of Guyana for further evaluation and disposition as a collaborative effort between GGI and the National Trust.

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Section 1:
Introduction

Contents

	Page
1 Introduction	1-1
1.1 General Background	1-1
1.2 Regulatory Setting	1-6
1.3 Resolution of Comments from IFC Review of ERM (2010)	1-8
1.4 Organization of ESIA Report	1-21

List of Tables

Table 1.2-1:	Summary of Major Permit and License Requirements - Aurora Gold Project
Table 1.3-1:	Concordance Table: Resolution of IFC Comments on Original ESIA

List of Figures

Figure 1.1-1:	Aurora Gold Project Location
Figure 1.1-2:	Aurora Gold Project Location (Buckhall to Aurora Site Transportation Corridor)
Figure 1.1-3:	Aurora Gold Project Mine Site Layout, Concession Boundary, and Environmental AOI

1 Introduction

1.1 General Background

Guyana Goldfields, Inc. (GGI) is undertaking the development of the Aurora Gold Project (Project), a proposed gold mining operation located in a remote, forested, and largely uninhabited area of northwestern Guyana (see **Figures 1.1-1 and 1.1-2**). GGI acquired 100% interest in the Project in 1998, and since that time has conducted a substantial number of surface and subsurface investigations to characterize the grade and location of the mineral resource, as well as a wide range of environmental and social baseline and impact assessment studies. GGI is incorporated in Canada and, in keeping with current Canadian securities regulations, has summarized the technical and economic feasibility of the Project in three studies over the last several years, all of which were designed to conform to the current iteration of National Instrument (NI) 43-101.¹ These studies are publically available on the System for Electronic Document Analysis and Retrieval (SEDAR) website², and include:

- “Aurora Gold Project - Guyana, South America, NI 43-101, Technical Report on Updated Preliminary Assessment” (AMEC, 2009);
- “NI 43-101 Technical Report, Feasibility Study, Aurora Gold Project, Guyana” (SRK, 2012); and
- “NI 43-101 Technical Report, Updated Feasibility Study, Aurora Gold Project, Guyana, South America” (TetraTech, 2013).

The (TetraTech, 2013) study defines a consolidated mine design with significantly reduced power requirements and a much smaller overall environmental footprint (see **Figure 1.1-3**) in comparison to the earlier Project layout presented in AMEC (2009) and SRK (2012). The TetraTech (2013) study forms the conceptual basis for the final design of the Project.

GGI has also committed to the establishment of environmental and social practices for the Project that not only comply with the legal requirements established by the nation of Guyana, but that also conform to:

- applicable International Finance Corporation (IFC) Performance Standards (PSs)(IFC, 2012);
- the IFC “Environmental, Health, and Safety General Guidelines” (IFC, 2007a);
- the IFC “Environmental, Health, and Safety Guidelines for Mining” (IFC, 2007b);
- the International Cyanide Management Code (ICMC);

¹ See http://www.osc.gov.on.ca/documents/en/Securities-Category4/ni_20110624_43-101_mineral-projects.pdf.

² See <http://www.sedar.com/>; this site is managed by the Canadian Securities Administrators (CSA), an association of Canadian provincial and territorial securities regulators.

Figure 1.1-1: Aurora Gold Project Location [Source: (TetraTech, 2013)]



Figure 1.1-2: Aurora Gold Project Location and Buckhall to Aurora Site Transportation Corridor

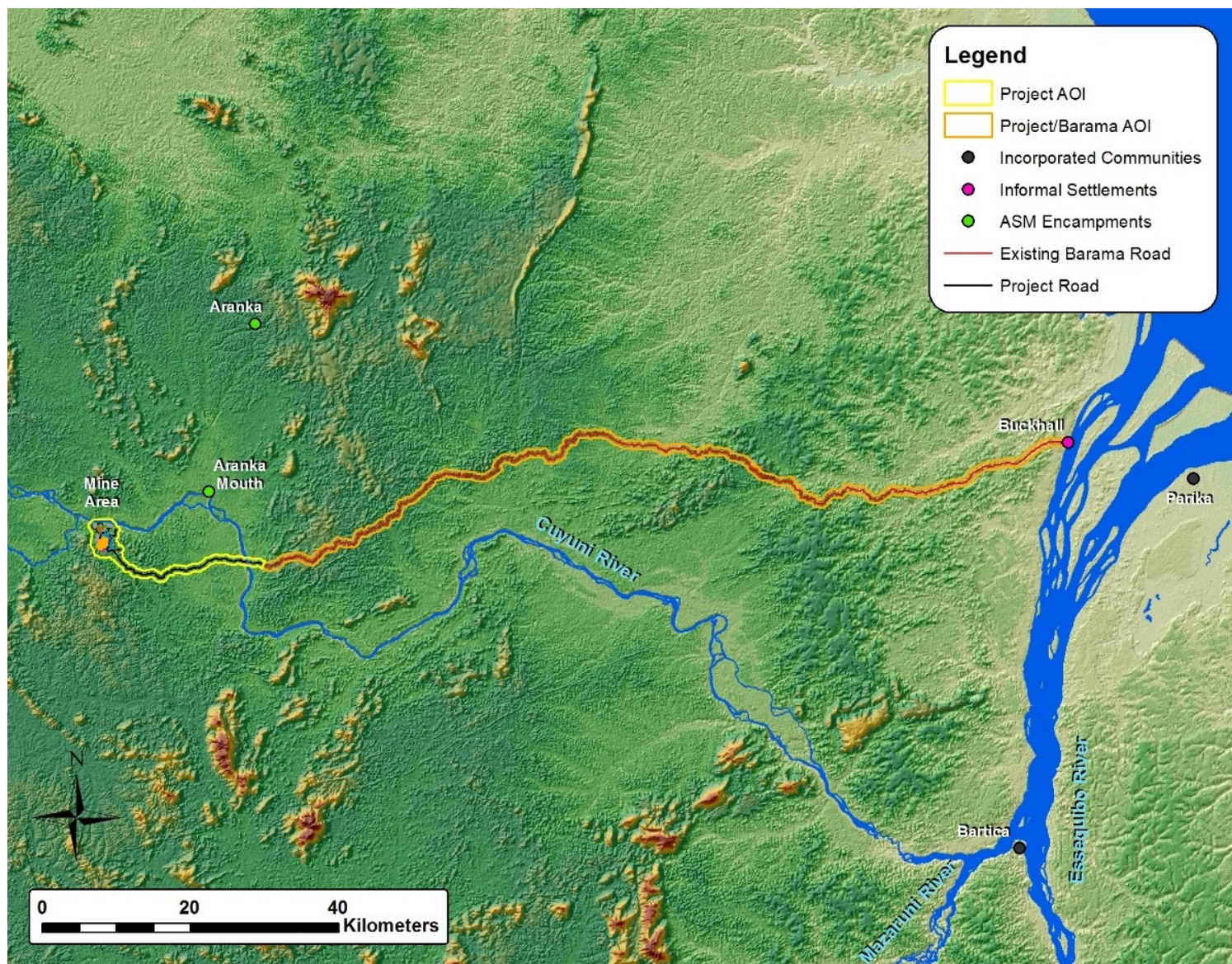
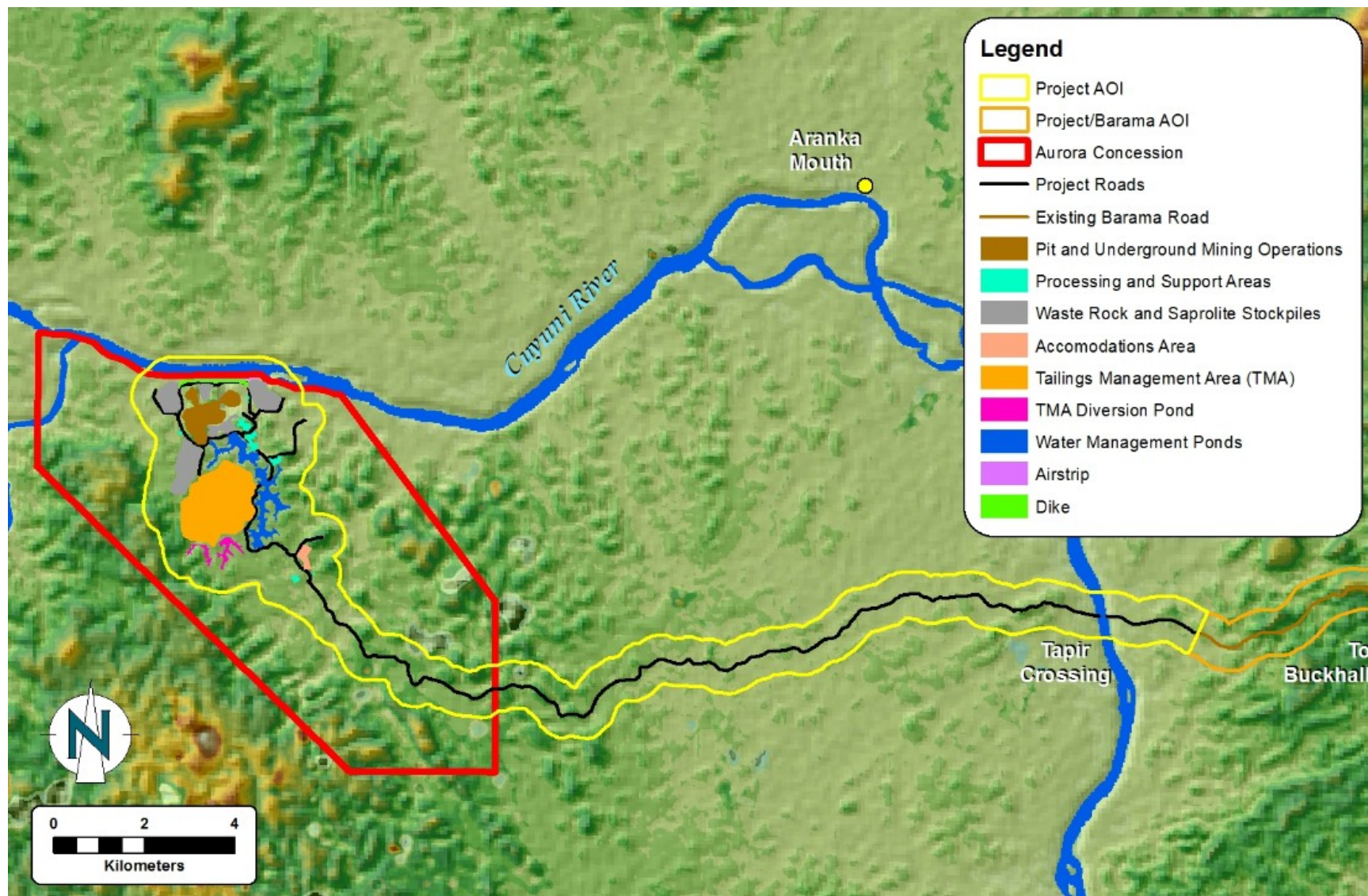


Figure 1.1-3: Aurora Gold Project Mine Site Layout, Concession Boundary, and Environmental AOI



- other applicable standards and guidelines as referenced therein; and
- other applicable Good International Industry Practices (GIIPs).

In keeping with the requirements of the IFC PSs (IFC, 2012), GGI has undertaken multiple studies in recent years to assess the environmental and social impacts likely to be associated with the Project. These studies have included:

- “Rapid Biodiversity Assessment of the ‘Golden Mile’ Area of Guyana Goldfields Aurora Concession in Guyana” [World Wildlife Fund (WWF) Guianas, 2006];
- “Final Report Environmental and Social Baseline Aurora Mining Concession for Guyana Goldfields” (GSEC, 2007);
- “IFC Public Health Technical Assistance Program for Guyana Goldfields, Phase 1” (Newfields, 2008);
- “IFC Public Health Technical Assistance Program for Guyana Goldfields, Phase 2” (Newfields, 2009);
- “Environmental and Social Impact Assessment – Aurora Gold Mine” (GSEC, 2009), a separate environmental and social impact assessment (ESIA) conducted for GGI in accordance with Guyana Environmental Protection Agency (Guyana EPA) requirements by Ground Structures Engineering Consultants Ltd. (GSEC);
- “Bio-assessment of the Cuyuni River near Aurora: Environmental and Economic Implications” (Duplaix, 2009; full text provided in **Appendix 4A**); and
- “Final [sic] Environmental and Social Impact Assessment (ESIA) of the Aurora Mine Project in Guyana:” (ERM, 2010), prepared to meet the IFC PSs by Environmental Resources Management, Inc. (ERM).

GGI has commissioned ENVIRON International Corp (ENVIRON) to prepare an updated ESIA, in compliance with current PSs (2012) that was designed to:

- build on the ERM (2010) version of the ESIA, accounting for Project design changes and the results of additional environmental and social investigations;
- address specific comments on ERM (2010) that were provided by IFC in 2010³;
- determine the applicability of (and, where determined to be applicable, properly address) the January 2012 version of the IFC PSs;

³ See “Preliminary recommendations to Guyana Gold’s ESIA prepared by ERM dated May 3, 2010” (IFC, 2010).

- reflect and maintain technical consistency with the current version of the Project design, as represented by the latest iteration of the NI 43-101 report (TetraTech, 2013); and
- be supported by a fully documented Environmental and Management System (ESMS), prepared in accordance with current PS 1 requirements, that describes the various mitigation measures, management plans, and standard operating procedures (SOPs) that will be developed and implemented by GGI over the life of the Project to properly address the Project's anticipated environmental and social risks and impacts.

1.2 Regulatory Setting

The Aurora Gold Project is subject to a number of regulatory permits and licenses issued by several different agencies of the Republic of Guyana. The primary permit or license requirements applicable to the Project are summarized in **Table 1.2-1**.

Table 1.2-1: Summary of Major Permit and License Requirements - Aurora Gold Project

Name	Permitting Agency	Status	Comments
Prospecting License (PL)	Guyana Geology and Mines Commission (GGMC)	Granted on June 29, 2004	The original Aurora property was encompassed by a PL covering an area of approximately 6,500 hectares (ha), centered at longitude 59° 45' W and latitude 6° 45' N.
Environmental Permit	Guyana EPA	Granted on September 28, 2010; renewal request required no later than April 30, 2015	Environmental Permit 20090114-GGIOO was granted by the Guyana Environmental Protection Agency (Guyana EPA) after reviewing the final National ESIA prepared for GGI by GSEC (GSEC, 2009). This review determined that all Guyana EPA, Environmental Assessment Board (EAB), GGMC, and other agency comments had been satisfactorily resolved. The Environmental Permit invokes a number of detailed regulatory compliance requirements. Once this updated ESIA has received all necessary approvals, GGI will prepare and submit a detailed amendment and request for renewal of the Environmental Permit that captures the Project changes and improvements reflected by this updated ESIA and TetraTech (2013).

Name	Permitting Agency	Status	Comments
Mining License (ML)	GGMC	Granted on November 18, 2011	The ML is contingent on Environmental Permit approval and grants GGI exclusive rights to build and operate the Aurora Gold Project. It is valid for 20 years with provisions for extension. The GGI ML is the first large-scale gold mining ML issued in Guyana since 1991.
Permit to construct road extension for mine site access	Guyana Ministry of Public Works	Granted in January 2010	This permit governs construction and maintenance of an approximately 33 kilometers (km) extension of the Barama (M3) Road 1.9 km southwest to Tapir Crossing on the Cuyuni River and west 32.1 km to the Aurora site.
Permit to use cyanide	GGMC	Pending	Before commencing any use of cyanide for mineral extraction in the operational phase of the Project, GGI must apply for a special cyanide permit from GGMC, providing information on: • the site, design or process, and amount of cyanide to be used; • site characteristics and layout; • distance to water bodies; • groundwater regime; • mode of tailings disposal; • possible effects on the environment; • a simplified description of the activity; and • strategies for minimizing the use of cyanide over the long term.
Permit to transport, store, handle, and use explosives	GGMC and Guyana Police Force (GPF)	Pending	GGMC and the GPF must approve the <i>Blasting Management Plan</i> to be developed for the operational phase of the Project, as well as the design and construction of on-site magazines, bulk explosive mixing systems, and associated health and safety and security arrangements.

Name	Permitting Agency	Status	Comments
Permit to operate solid waste landfills	Guyana EPA, Ministry of Health, and Central Housing and Planning Authority	Pending	Per the “Criteria for the Identification and Approval of Landfill Sites for Solid Waste Disposal in Guyana” (Guyana EPA, no date), Guyana EPA must approve applications for permission to operate new sanitary landfills at the Aurora mine site and the Buckhall logistics center and will issue permits to operate upon approval. Applications for permission to plan such facilities must also be obtained from the Central Housing and Planning Authority (Ministry of Housing and Water) and the Central Board of Health (Ministry of Health).
Permit to operate upgraded airstrip	Guyana Civil Aviation Authority (GCAA)	Pending	GCAA must approve the design and construction of the upgraded airstrip at the Aurora site, and will issue a revised or renewed permit to operate upon approval.

It should be noted that as part of the updated NI 43-101 report documented in TetraTech (2013), GGI commissioned an independent assessment of all mineral tenure, surface rights, rights of access, and other permitting issues by independent legal counsel. A copy of the results of this review was appended to TetraTech (2013) and confirm that all permits required to support the start of major Project construction have been properly issued.

1.3 Resolution of Comments from IFC Review of ERM (2010)

As noted in Section 1.1, in the development of this updated ESIA and the current iteration of the Project design represented in TetraTech (2013), GGI has committed to the resolution of comments received from IFC that specifically pertained to the ERM (2010) ESIA. For the convenience of the reviewer, **Table 1.3-1** presents the noted IFC comments and provides guidance on how each comment was resolved in this updated ESIA and/or the TetraTech (2013) NI 43-101 report.

Table 1.3-1: Concordance Table: Resolution of IFC Comments on Original (ERM, 2010) ESIA

1. Comments on General ESIA Approach		
IFC Comment⁴	Comment Resolution	FS/ESIA Location References
1. A review of the ESIA dated May 3, 2010 was carried and several recommendations/comments were identified which are presented below. We understand the Feasibility Study for the Project has been postponed until the fourth quarter of 2011, and therefore, we recommend that the following be carried out by Guyana Gold: a) Incorporate the findings and recommendations contained within the current version of the ESIA into the design for the Project and the final Feasibility Study Report; b) Address the comments and recommendations identified by IFC within this document and incorporate them into the revised ESIA; and c) Revise and update the ESIA for it to be fully integrated with the final Feasibility Study Report to be ready 4Q of 2011.	1(a): IFC comments have been considered and, where appropriate, have been integrated into the design of the Project as represented in the final Feasibility Study (FS) [i.e.,(TetraTech, 2013)] and the content of the updated ESIA, as noted in this table. 1(b): IFC comments and recommendations from the initial review of (ERM, 2010) have been integrated into (TetraTech, 2013) as well as this updated ESIA [“Final Updated Environmental and Social Impact Assessment - Aurora Gold Project” (ENVIRON, 2013)], as indicated elsewhere in this table. 1(c): The final revised and updated ESIA is complete and considers: - the reduced environmental footprint and final technical parameters of the Aurora Gold Project, as defined by (TetraTech, 2013); - the January 2012 updates to the IFC PSs; - the results of a series of physical, biodiversity/habitat, social, and cultural heritage baseline update tasks undertaken on GGI's behalf by ENVIRON, GSEC, and other specialists in 2011 and 2012; - updates to the initial iteration of Project-specific Environmental and Social Management System (ESMS) documentation, as appropriate to ensure consistency with the requirements of PS 1 and to otherwise address the practical management needs likely to be encountered in major construction and subsequent phases of the Aurora Gold Project; and - the resolution of IFC comments on the original ESIA (ERM, 2010), as reflected in (TetraTech, 2013) and as summarized in this table.	1(a): See (TetraTech, 2013) and the general text of this updated ESIA (ENVIRON, 2013)]. 1(b): See the remaining entries in this table and the general text of this updated ESIA. 1(c): See the remaining entries in this table and the general text of this updated ESIA.

⁴ Source: IFC, December 20, 2010, “Preliminary recommendations to Guyana Gold’s ESIA prepared by ERM dated May 3, 2010”

2. Comments on the Design of the Project		
IFC Comment	Comment Resolution	FS/ESIA Location References
2.1: According to the May 3 ESIA [i.e., (ERM, 2010)], the document was prepared based on preliminary design information from AMEC (in parallel to the Pre-Feasibility Phase for the Project). Therefore, a number of key components were not yet finalized during its preparation including: design details of mine infrastructure, road routes, final water source options, waste management flows, treatment, disposal and discharge points for liquid effluents, information on the cyanide treatment system and storm water management systems, etc. It is important this information be incorporated into the final ESIA for all potential impacts to be fully evaluated and for them to be adequately addressed within the Environmental and Social Management Plan (ESMP).	GGI concurs with IFC's recommendation; this updated ESIA incorporates the reduced environmental footprint and final technical parameters of the Aurora Gold Project as defined by (TetraTech, 2013). The updated ESIA is supported by a fully documented ESMS designed to ensure consistency with the requirements of PS 1.	See Section 7 of this table, as well as Section 7 and Appendices 7A, 7B, and 7C of this updated ESIA.
2.2: The ESMP Section of the ESIA provides several environmental mitigation measures specific to the design of the Project to be able to address the most significant impacts. This includes for example, the installation of liners and secondary containment systems for key facilities, leak detection systems, the need for erosion control measures and drainage, ARD characterization and management, tailings design criteria, the need for compliance with the International Cyanide Management Code, etc. These recommendations should be included in the final design of the Project and in the revised ESIA.	IFC comments have been considered and, where appropriate, have been integrated into the design of the Project as represented in (TetraTech, 2013) and this updated ESIA, as noted in the comment resolutions presented throughout this table. This updated ESIA is supported by a fully documented ESMS designed to ensure that the mitigation measures developed in the ESIA are implemented in actual practice, consistent with the requirements of IFC Performance Standard 01. As noted in Section 7, the ESMS is embodied in an <i>ESMS Plan</i> , which will be supported by a suite of Management Plans and SOPs developed to address a full range of anticipated impacts, including the management of cyanide, water management, erosion control, and the other issues noted in the IFC comment. These plans and SOPs will be initially issued with a specific focus and level of detail that is appropriate for the major construction phase of the Project, and will be periodically updated to keep pace with Project changes, within the context of the change management process defined by the <i>ESMS Plan</i> .	See Section 7 of this table, as well as Section 7 and Appendices 7A, 7B, and 7C of this updated ESIA.
2.3 If new operations and footprint areas (such as the hydropower project or the Aranka Property mining operations) are included as part of the Project, they must be incorporated (at the necessary level of detail, including both social (IP areas/other communities) and environmental aspects) both within the final Feasibility Study Report and also within the revised ESIA.	Not applicable; the design assumptions presented in (TetraTech, 2013) do not include hydropower development, and the Project footprint has been substantially reduced since the original ESIA (ERM, 2010) was first issued. No Aranka concession areas are included as part of the Aurora Gold Project.	Not applicable due to Project design changes; no action required.

3. Comments on the Design & Project Description Section		
IFC Comment	Comment Response	FS/ESIA Location References
3.1 The ESIA mentions the need for more information regarding the design of the waste rock and saprolite stockpiles and the tailings management facility in order to address potential impacts on ground water. Based on the fact that ground water is indicated at around 1 to 4 meters bgs, the potential for ground water impacts at the tailings facility is considered high. In the case of the rock stockpiles, more information on ARD potential is needed to assess the significance of impacts. In order to address the above, mitigation measures within the design of the Project are warranted. These would include the installation of an impermeable liner below the tailings facility and, based on their potential for ARD generation, also below the waste rock stockpiles.	GGI has commissioned additional geotechnical, geochemical, and environmental studies to further examine potential impacts of the Tailings Management Area (TMA) on groundwater and the potential for generation of acid rock drainage (ARD) at the waste rock stockpiles and/or pit walls. Results of geochemical testing indicate that the overall potential for generation of ARD in any stockpile is very low, and placement of an impermeable liner beneath the stockpiles to preclude ARD impacts to groundwater is not warranted. The TMA and Mine Water Pond (MWP) designs both call for construction within a cleared saprolite basin with naturally low hydraulic conductivity, as well as the construction of saprolite embankments in two lifts. The TMA has also been subjected to an independent engineering review to assess the overall adequacy of the conceptual design; the design was determined to be feasible with no fatal flaws noted. The results of this review are included for reference in Appendix 9D of the updated ESIA. Because identical basin and embankment construction methods will be used for the MWP, the adequacy of the MWP design relative to the same (IFC 2007b) criteria may be inferred. In addition, mine lifecycle water quality modelling studies were conducted to assess surface and groundwater quality impacts at the TMA and MWP. Results are documented in Appendix 9C, and indicate that provided that sufficient settling pond capacity is provided to accommodate potentially high total suspended solids (TSS) values in MWP effluent (and TMA effluent in certain limited operational conditions), the effluent limits in Table 1 of (IFC, 2007b) should not be exceeded.	See Sections 20.1 and 20.3.1 of (TetraTech, 2013). See also Section 9.6 and 9.9 and Appendix 9A in this updated ESIA; note that the latter contains the full text of three studies conducted to evaluate the geochemistry of the ore body and mine tailings, with emphasis on the potential for generation of ARD conditions; the reports are: • “An Investigation into Geochemical and Geotechnical Characterisation of Guyana Goldfields Mine Tailings” (SGS Canada, 2010); • “Aurora Gold Project – Static Acid Rock Drainage and Metal Leaching (ARD/ML) Interpretation” [Klohn Crippen Berger (KCB), 2012a]; and • “Aurora Gold Project – Acid Rock Drainage and Metal Leaching Characterization- Kinetic Test Results” (KCB, 2012b). See also Appendix 9C, which presents the results of the noted water quality modelling studies, and Appendix 9D, which contains the results of the independent technical review of the conceptual design of the TMA.
3.2 The ESIA indicates that no geochemical information was provided by the Company (or within the AMEC report) on ARD potential from waste rock or other material. If ARD generation potential is high, impacts on surface, ground water and downstream users could be significant. Adequate characterization of the rock materials is needed within the ESIA to determine ARD potential. If ARD generation potential is high, this impact needs to be adequately managed within the design of the Project and within the ESIA.	See above; GGI has commissioned additional geotechnical and geochemical baseline studies to further elaborate the potential for generation of ARD at the waste rock stockpiles and/or pit walls. Results of these tests indicate that the overall potential for generation of ARD is very low over the life of the mine. Runoff and groundwater infiltration into the open pit, underground mine, and runoff from all waste rock stockpiles will nevertheless be monitored for pH and other contaminants; should any ARD trends be noted, suitable buffering agents will be introduced into the MWP or settling/treatment ponds constructed downgradient from each stockpile as appropriate for the observed condition.	See above.
3.3 According to the ESIA, limited information is provided within the Pre-Feasibility Report on erosion control and sediment control measures for the various mine facilities. Potential contamination of surface waters from sediment and erosion is considered a significant impact and, therefore, should be addressed in more depth within the design of the Project, Feasibility Study Report and within the ESIA.	Erosion control and sediment management measures have been elaborated in (TetraTech, 2013) and this updated ESIA.	See Section 20.1 of (TetraTech, 2012); see also the discussion of impacts and mitigation measures in Sections 6.3, Table 6.3-1, 9.6 and 9.9 of this updated ESIA. The initial iterations of the Project <i>Erosion Prevention and Control Plan</i> and its supporting SOPs are also provided in Appendices 7B and 7C, respectively.

3. Comments on the Design & Project Description Section		
IFC Comment	Comment Response	FS/ESIA Location References
3.4 According to the ESIA, no information was provided on the type of treatment and monitoring planned for the water management pond, where contaminated water from the open pits, underground operations and other potentially contaminated water will be pumped. This should be addressed in more depth in the design of the Project, Feasibility Study Report and within the ESIA.	With respect to the contaminants noted in the (IFC, 2007b) Table 1 Effluent Standards, potential contaminants of interest from the pit areas and underground operations may be expected to include petroleum hydrocarbons (from potential accidental leakage or from fuelling or servicing spills involving haul trucks, drill rigs, loaders, and other motorized equipment) as well as naturally occurring metals. This water will be pumped to the MWP, which will also receive runoff from one waste rock and one waste saprolite stockpiles and mill area roadways or laydown areas that cannot be practically provided with secondary containment. The MWP designs calls for construction within a saprolite basin with naturally low hydraulic conductivity, as well as the construction of saprolite embankments; it is designed to provide substantial settlement and dilution capacity, and effluents are expected to be maintained below (IFC, 2007b) limits. Mine lifecycle water quality modelling studies were conducted to assess surface and groundwater quality impacts to the MWP in normal operating conditions; results are documented in Appendix 9C, and indicate that provided that sufficient settling pond capacity is provided to accommodate potentially high TSS values in MWP effluent (and TMA effluent in certain limited operational conditions), the effluent limits in Table 1 of (IFC, 2007b) should not be exceeded. It should also be noted that both MWP and TMA designs both call for construction within a cleared saprolite basin with naturally low hydraulic conductivity, as well as the construction of saprolite embankments in two lifts. The TMA has also been subjected to an independent engineering review to assess the overall adequacy of the conceptual design; the design was determined to be feasible with no fatal flaws noted. The results of this review are included for reference in Appendix 9D of this updated ESIA. Because identical basin and embankment construction methods will be used for the MWP, the general adequacy of the MWP design relative to the same (IFC 2007b) criteria may be inferred.	See Sections 18.2.6, 18.2.7, 20.3.3, and 20.3.4 of (TetraTech, 2013). See also Section 6.3, Table 6.3-1, and Section 9.6 of this updated ESIA, as well as Appendix 9C, which presents the results of the noted water quality modelling studies, and Appendix 9D, which contains the results of the independent technical review of the conceptual design of the TMA.
3.5 According to the ESIA, no engineering plans or details were provided in the Pre-Feasibility Report regarding the construction of the river dike. The document mentions that based on the proximity of the Cuyuni River, short circuiting of surface water around or under the river dike may result in surface water infiltration into the open pit and underground mine during ground water de-watering activities. Stability of the river dike may also be an issue as a result of surface water flow and erosion around the base foundation of the dike system. This should be addressed in more depth in the design of the Project, Feasibility Study Report and within the ESIA.	Appendix D of (TetraTech 2013) evaluates the projected performance of the Cuyuni River dykes with respect to minimizing inflows to the open pit and underground areas. Dyke configuration has been modified as part of the overall consolidation of the environmental footprint of the Project. Regular monitoring of the Cuyuni dykes and all other constructed earthworks is a key consideration addressed in the <i>Erosion Prevention and Control Plan</i> and <i>ESHS Monitoring Plan</i> developed as part of the Project ESMS, and will also be reflected in the comprehensive <i>Water Management Plan</i> that will be prepared prior to the operational phase of the Project.	See Appendix D of (TetraTech 2013). See also see also Section 9.6 of this updated ESIA, as well as drawings C-105 and C-115 in Appendix 2A, and the initial iterations of the <i>ESHS Monitoring Plan</i> and <i>Erosion Prevention and Control Plan</i> in Appendix 7B.

3. Comments on the Design & Project Description Section		
IFC Comment	Comment Response	FS/ESIA Location References
3.6 Although a recommendation is included within the ESMP Section of the ESIA to comply with the International Cyanide Management Code (ICMC) guidelines, limited information on cyanide management is found within the Project Description / Design Section of the ESIA. The Feasibility Study should address those requirements of the ICMC applicable to design and this information shall also be included in the Project Description Section of the ESIA.	Section 20 of (TetraTech, 2013) , Section 9.7, and Section 10.3 of this updated ESIA address how the ICMC guidelines were interpreted in relation to the design of the processing plant, tailings pipeline, and TMA, as well as the operation of the transportation corridor to the mine. GGI has elected to purchase cyanide in dry briquette form transported in dedicated, stainless steel ISO shipping/mixing containers, so no separate cyanide storage warehouse or onsite mixing areas will be required. In addition, an updated <i>Cyanide Management Plan</i> based on the requirements of the ICMC will be developed and implemented as part of the Project ESMS prior to cyanide being delivered onsite at the beginning of the operational phase of the Project.	See Section 20 of (TetraTech, 2013) as well as Section 9.7, Section 10.3, and Figure 10.3-1 in this updated ESIA.
3.7 An Alternatives Analysis for the various major components of the Project was not provided in the ESIA and needs to be carried out to feed into the design phase of the Project. Different alternatives for the major facilities and infrastructure should be evaluated on their economic, environmental, social and technical feasibility with regards to location/footprint and/or processes, and justifications provided for the selected design. (See Annex 1 of IFC's Guidance Note # 1 Social and Environmental Assessment and Management Systems for additional guidance).	Section 3 of the updated ESIA includes the requested alternatives analysis for major facilities and infrastructure that is reflected in the selected design options described in (TetraTech, 2013).	See Section 3 and Table 3.0-1 of this updated ESIA.
4. Comments/Questions on the Baseline Section		
IFC Comment	Comment Response	FS/ESIA Location References
4.1 Has a comprehensive hydro-geological assessment been carried out to characterize local and more regional ground water resources in the area? Is information available on the characteristics of the aquifer, including vertical/lateral extent, ground water flow velocities and gradients?	GGI has commissioned additional hydrogeological baseline studies to further characterize local and regional groundwater resources and their behaviour relative to mine design alternatives.	See Section 16.1 in (TetraTech, 2013) and Section 9.6.2 of this updated ESIA. A full text copy of the hydrogeological study that supports the selected mine design alternative is also provided in Appendix 9B of the ESIA.
4.2 All new footprint areas for the Project that will be included in the final Feasibility Study should be assessed with regards to biodiversity and for the criteria included in Performance Standard # 6 (Biodiversity Conservation & Sustainable Natural Resource Management). Included in this process is the need for the collection of adequate and representative flora and fauna data to be able to identify sensitive species and natural and/or critical habitats.	The consolidated design reflected in (TetraTech, 2013) represents a substantial reduction of the Project's environmental footprint (from 20 km ² to 12 km ²), which is achieved in part by the preferential use of previously impacted land for major Project components (e.g., upgrading the existing airstrip vs. an expanded "greenfield" airstrip location). GGI also commissioned additional dry- and wet-season biodiversity studies by ENVIRON and GSEC in 2011 and 2012, the results of which are summarized in Sections 4 and 12 of the updated ESIA. No endangered species or critical habitats were identified; the Project site is considered to be "natural" habitat, and provisions are made for the development of offset measures to ensure that the "no net loss" considerations in PS 6 are properly addressed.	See Sections 4 and 12 of this updated ESIA.

5. Comments/Questions on Biodiversity		
IFC Comment	Comment Response	FS/ESIA Location References
5.1 In 2009 a Rapid Biodiversity Assessment (RBA) was carried out by ERM in the Project area of influence including the area of the Golden Square Mile, the tailings management area (as identified at the time of the survey), the water management pond, and the Julian Ross Itabu areas. The ESIA mentions that the survey was carried out from 28 April through 5 May, 2009. Have any other biodiversity assessments (aside from the 2009 survey) been done at these locations? Are 8 days considered sufficient to be able to correctly characterize the area?	See above; the consolidated design reflected in (TetraTech, 2013) represents a substantial reduction of the Project's environmental footprint, which is achieved in part by the preferential use of previously impacted land for major Project components. GGI also commissioned additional dry- and wet-season biodiversity studies by ENVIRON and GSEC in 2011 and 2012, the results of which are summarized in Sections 4 and 12 of the updated ESIA.	See Sections 4 and 12 of this updated ESIA.
5.2 It is recommended that the direct areas of influence of the Project be "mapped" to be able to identify areas with more biodiversity value, which are more intact and, which would be considered as natural habitats or which resemble the natural ecology. Information shall also be provided on the potential for any species considered as threatened, vulnerable or endangered to use these areas.	See above; the consolidated design reflected in (TetraTech, 2013) represents a substantial reduction of the Project's environmental footprint. GGI also commissioned additional dry- and wet-season biodiversity studies by ENVIRON and GSEC in 2011 and 2012, the results of which are summarized in Sections 4 and 12 of the updated ESIA. The environmental area of influence (AOI) is estimated at 0.5 km from the perimeter of the reduced Project footprint plus a 0.5 km buffer on either side of the access road to the site. The resulting AOI is mapped in Figures 4.1-1 and 4.1-2 of the updated ESIA.	See Sections 4 and 12 and Figures 4.1-1 and 4.1-2 in this updated ESIA.
5.3 To assess flora and fauna along the proposed access route, a Rapid Biodiversity Assessment was carried out in 2009 over a 5 day period and extending 0.5 km on either side of the access road centreline (as defined at the time of ESIA preparation). A review needs to be carried out to confirm that the area surveyed in 2009 is the actual (and final) location of the road as defined in the final Feasibility Study.	See above; Figure 4.1-2 depicts the locations of biodiversity sampling points with respect to the original study area and the AOI from the reduced Project footprint. Note that the road sampling areas are very close to the final road alignment, and exhibit habitat types identical to those which have been thoroughly examined in the biological baseline field sampling efforts; described in Sections 4 and 12. The road sampling areas are also well within the final AOI.	See Sections 4 and 12 and Figure 4.1-2 in this updated ESIA.
5.4 According to the ESIA, the location of the proposed tailing management area lies largely in a " <i>relatively intact forest</i> " outside of the area that has been surveyed during the two baseline field studies. The ESIA needs to expand on the information regarding the habitat in this area. Is this largely natural habitat? Could this area harbor the presence of sensitive species considered as threatened, vulnerable or endangered by IUCN?	See above; as noted in Sections 4 and 12 of the updated ESIA, the site is considered to be natural habitat, and does not contain species determined to be threatened, vulnerable or endangered. Provisions are made for the development of offset measures to ensure that the "no net loss" considerations for natural habitat in PS 6 are properly addressed.	See Sections 4 and 12 of this updated ESIA.

6. Comments/Questions on Impacts Evaluation		
IFC Comment	Comment Response	FS/ESIA Location References
6.1 The ESIA mentions loss of aquatic habitat will occur in the open pit area, tailings management area, water management pond and other areas where major conversion of the land surface is required. The ESIA further mentions that flow into streams and creek beds downstream of the tailing and water management ponds will be altered and, therefore, considers this modification of hydrologic flow patterns as a major impact. The document further states that there are no plans to construct diversions for the water courses that will be affected, for example in the stream catchment of the future tailings management area. It is recommended that mitigation measures be included within the design of the Project to avoid impacts on surface water flow in the watercourses downstream of these facilities.	A conceptual water management plan is described in Section 20.3.4 of (TetraTech, 2013) that will form the technical basis of a comprehensive, documented <i>Water Management Plan</i> that will be developed as part of the Project ESMS prior to the operational phase. The primary objectives of this plan will be to: divert as much water as possible away from the open pit and TMA; minimize the use of fresh water; maximize recirculation of process water; reduce the sediment load in runoff from waste rock stockpiles; maintain trafficable site access during storm events; and to maintain discharge water quality values below the effluent discharge guidelines defined by (IFC, 2007b). Clean runoff will be collected and routed around mining operations and returned to the environment to maintain appropriate biological base flows. It is anticipated that runoff will be collected in ditches alongside the site access roads and haul roads, and routed to dedicated diversion channels. Where topography and site layout make ditching impractical, runoff will be collected into simple ponds and pumped to appropriate discharge points	See Sections 20.1 and 20.3.1 of (TetraTech, 2013) as well as Section 6 and Table 6.3-1 of the updated ESIA.
6.2 According to the ESIA, infiltration of water from the tailings management area, water management pond and waste management areas along with leaching of minerals into solutions are considered as potential major negative impacts. The Feasibility Study should address mitigating these potential impacts for example through the use of impermeable systems below these facilities and adequate drainage control.	As noted above, The TMA and MWP designs both call for construction within a cleared saprolite basin with naturally low hydraulic conductivity, as well as the construction of saprolite embankments in two lifts. The TMA has also been subjected to an independent engineering review to assess the overall adequacy of the conceptual design; the design was determined to be feasible with no fatal flaws noted. The results of this review are included for reference in Appendix 9D of this updated ESIA. Because identical basin and embankment construction methods will be used for the MWP, the adequacy of the MWP design relative to the same (IFC 2007b) criteria may be inferred. In addition, mine lifecycle water quality modelling studies were conducted to assess surface and groundwater quality impacts at the TMA and MWP. Results are documented in Appendix 9C, and indicate that if sufficient settling pond capacity is provided to accommodate potentially high TSS values in MWP effluent (and TMA effluent in certain limited operational conditions), the effluent limits in Table 1 of (IFC, 2007b) should not be exceeded. GGI has also commissioned additional geotechnical, geochemical, and environmental studies to further examine potential impacts of the Tailings Management Area (TMA) on groundwater and the potential for generation of acid rock drainage (ARD) at the waste rock stockpiles and/or pit walls. Results of geochemical testing indicate that the overall potential for generation of ARD in any stockpile is very low, and placement of an impermeable liner beneath the stockpiles to preclude ARD impacts to groundwater is not warranted. As noted above, the TMA and MWP designs both call for construction within a cleared saprolite basin with naturally low hydraulic conductivity, as well as the construction of saprolite embankments.	See Sections 18.2-5, 18.2.6, 18.2.7, 20.3.1, 20.3.2, 20.3.3, and 20.3.4 of (TetraTech, 2013). See also Section 6.3, Table 6.3-1, and Sections 9.6 and 9.10 of this updated ESIA. See drawings C-105 and C-111 through C-119 and N-100 in Appendix 2A to this updated ESIA. See also Appendix 9A, which contains the full text of three studies conducted to evaluate the geochemistry of the ore body and mine tailings, with emphasis on the potential for generation of ARD conditions; the reports are: • “An Investigation into Geochemical and Geotechnical Characterisation of Guyana Goldfields Mine Tailings” (SGS Canada, 2010); • “Aurora Gold Project – Static Acid Rock Drainage and Metal Leaching (ARD/ML) Interpretation” [Klohn Crippen Berger (KCB), 2012a]; and • “Aurora Gold Project – Acid Rock Drainage and Metal Leaching Characterization- Kinetic Test Results” (KCB, 2012b). See also Appendix 9C, which presents the results of the noted water quality modelling studies, and Appendix 9D, which contains the results of the independent technical review of the conceptual design of the TMA

6. Comments/Questions on Impacts Evaluation		
IFC Comment	Comment Response	FS/ESIA Location References
6.3 Based on the proximity of the Cuyuni River to the pit, the ESIA recommends installation of an impermeable barrier below grade and extension of the dike to the west to further protect the mine from potential surface water infiltration. These recommendations should be evaluated from an engineering/hydrogeological standpoint and, if needed, addressed in the upcoming Feasibility Study and also in the ESIA.	As noted above, river dyke configuration has been modified as part of the overall consolidation of the environmental footprint of the Project. Appendix D of (TetraTech 2013) evaluates the projected performance of the Cuyuni River dykes with respect to minimizing inflows to the open pit and underground areas. Regular monitoring of the Cuyuni dykes and all other constructed earthworks is a key consideration addressed in the <i>Erosion Prevention and Control Plan</i> and <i>ESHS Monitoring Plan</i> developed as part of the Project ESMS, and will also be reflected in the comprehensive <i>Water Management Plan</i> that will be prepared prior to the operational phase of the Project.	See Appendix D of (TetraTech 2013). See also Section 6, Table 6.3-1 , and Section 9.6 of this updated ESIA; drawings C-105 and C-115 in Appendix 2A , and the initial iterations of the <i>ESHS Monitoring Plan</i> and <i>Erosion Prevention and Control Plan</i> in Appendix 7B . See also Appendix 9B , which contains the full text of the hydrogeology study originally included as Appendix D of (TetraTech, 2013)
6.4 According to the ESIA, extensive ground water dewatering (estimated anywhere from 6,000 m ³ /d to 16,000 m ³ /d) will be required to facilitate pit and underground mining operations. The ESIA predicts that this will disrupt the existing ground water flow regime and result in flow into the mine from areas surrounding the mine footprint. It is also predicted that this may include infiltration of surface water from the Cuyuni River because the river may be hydraulically contacted to shallow groundwater in the vicinity of the open pit. The ESIA considers this as a moderate impact due to the remote location of the Project and lack of any known water supply wells, and further indicates that no mitigation measures are proposed. It is recommended that this risk be re-evaluated from a hydrogeological standpoint and documented within the Feasibility Study and ESIA. Also, more information is needed to justify the lack of any mitigation measures. Would any ecosystem services downstream of the open pit be impacted?	Appendix D of (TetraTech 2013) documents a detailed hydrogeological study conducted to assess hydrogeological conditions and inflows into the preferred mine configuration model. Regular monitoring of the Cuyuni dykes. Pit walls, and all other constructed earthworks is a key consideration addressed in the <i>Erosion Prevention and Control Plan</i> and <i>ESHS Monitoring Plan</i> developed as part of the Project ESMS, and will also be reflected in the comprehensive <i>Water Management Plan</i> that will be prepared prior to the operational phase of the Project. The potential impact of the Project on ecosystem services was evaluated in Section 12 of the updated ESIA; no Type I ecosystem services (upon which affected communities might depend) were determined to exist, since there are no communities in reasonable proximity to the Aurora site, and the only Type II service (upon which GGI might be considered to depend) is provisioning of water for industrial uses at the Aurora site, and for firefighting at Buckhall. However, GGI has no direct management control over or significant influence on the provisioning of water at either location. At the Aurora site, there will be no direct abstraction of water from the Cuyuni River. Raw water will be obtained from water wells drilled into the underlying bedrock, collection of surface water from creeks, and rain water harvesting systems; potable water will be obtained from rain water harvesting systems. During the operational phase of the Project, water will be recycled for industrial purposes to minimize fresh water extraction needs and will be temporarily retained and diluted to manage sedimentation and overall effluent quality. However, as noted in Section 20.2 of (TetraTech, 2013) the net water balance for the Project is expected to be significantly positive, and the Project design assumes that excess water will be continuously discharged to the environment. At Buckhall, firefighting water will be pumped from the Essequibo River on an as-needed basis. With respect to potential impacts on the Cuyuni River, given its very large drainage area [approximately 53,500 km² (AMEC, 2009)] and the very substantial (>2 meters) average annual rainfall in the Cuyuni Basin, the Project's likely effect on Cuyuni River flow rates are not expected to be significant.	See Section 16. 1 of (TetraTech, 2013). See also Section 12 in the updated ESIA as well as Appendix 9B , which contains the full text of the hydrogeology study originally included as Appendix D of (TetraTech, 2013)

6. Comments/Questions on Impacts Evaluation		
IFC Comment	Comment Response	FS/ESIA Location References
6.5 According to the ESIA, during closure, failure of the two perimeter dams associated to the tailings management area and the three perimeter dams associated with the clarification / water management pond may significantly impact surface waters in the vicinity of the site, as well as ground water quality in the underlying aquifer. This is considered to be a potential major impact. As indicted in IFC's EHS Guidelines for Mining, an independent review of the design of the tailings dam should be carried out to confirm geotechnical and hydraulic stability.	The TMA has also been subjected to an independent engineering review to assess the overall adequacy of the conceptual design; the design was determined to be feasible with no fatal flaws noted. The results of this review are included for reference in Appendix 9D of this updated ESIA. The strength and safety of the TMA embankments will be evaluated in conjunction with completion of final design.	See Section 6.3, Table 6.3-1, and Appendix 9D of this updated ESIA. The latter contains the results of the independent technical review of the conceptual design of the TMA.
6.6 Construction of the road to the mine site and increased traffic on the road will increase the number of people passing through, and thereby increase the potential for unauthorized activities such as hunting or timber harvesting. These roads could also facilitate the influx of small scale or medium scale miners with related environmental, social and health impacts. This potential impact is rated in the ESIA as moderate. However, it is considered that this impact has high potential and is of high significance, and, therefore should be more comprehensively addressed in the ESMP Section of the ESIA (see further comments below).	GGI concurs that influx management will be an important task in all phases of mine life, and will implement an <i>Influx Management Plan</i> within the context of the ESMS developed to support the ESIA for the Project. It should be noted that management of influx is also identified as a specific obligation under GGI's current Environmental Permit (Guyana EPA, 2010)	See Section 6.3, and Table 6.3-1 of the updated ESIA, as well as the initial iteration of the Project's <i>Influx Management Plan</i> in Appendix 7B .
6.7 The ESIA mentions that the road from Parika to Georgetown is not included in the ESIA analysis indicating that it is well developed and that "there should not be a measurable increase in traffic on an already busy road". The ESIA needs to include more quantitative information to support this conclusion. Has a road traffic assessment been carried out to confirm this? If further evaluation considers this impact significant, is there quantitative information to characterize those villages along this road which could be impacted?	This questions is addressed in Section 5 of this updated ESIA; to summarize, Project materials and equipment will be transported directly to Buckhall via barge from Georgetown or the Port of Kingston, completely bypassing (and thereby having no impact on) the Port of Parika. GGI workers will be transported to the mine site by company vehicles using the Demerara River toll bridge and Georgetown - Parika road. From Parika, they will cross the Essequibo River to Buckhall using motorboats owned or leased by GGI. In 2011, it is understood that on average, 7,500 vehicles per day crossed the Demerara bridge. Additional traffic studies conducted for the Government of Guyana in 2012 as part of the West Coast Demerara Road Improvement Project indicate that a maximum daily average of 6,294 vehicles travelled from the Demerara bridge on towards Parika. GGI estimates that the Project will make no more than 20 trips per week from Georgetown to Parika. As this represents only 0.3% of the maximum average daily traffic, the impact of Project traffic is not considered to be significant. Some limited interaction with the community may occur with workers in transit, but as all surface travel arrangements and schedules are directly controlled by GGI, no significant impacts are considered likely. Parika is therefore not considered to be in the Project's direct area of influence.	See Section 5 of this updated ESIA.

6. Comments/Questions on Impacts Evaluation		
IFC Comment	Comment Response	FS/ESIA Location References
6.8 The ESIA has limited information on managing cumulative impacts for the Project (page 8-6). The document does mention that in order to address cumulative impacts from ASM and related pressures on biodiversity and water quality “a long term, multi-stakeholder regional planning program would be required”. More guidance on what this actually means is recommended to help the Company address this issue early on.	See Section 3.1 of the updated ESIA; these issues will be collectively addressed over the life of the mine and into the post-closure phase by three key action plans: the <i>Influx Management Plan</i> ; <i>Decommissioning, Reclamation, and Closure Plan</i> ; and the <i>Community Relations Management Plan</i> . All of these plans will be kept current with the needs of the Project via the change management processes defined by the <i>ESMS Plan</i> .	See Section 3.1 of the updated ESIA; see also Appendix 7A , <i>ESMS Plan</i> and Appendix 7B , which contains initial iterations of the <i>Influx Management Plan</i> ; <i>Mine Reclamation and Closure Plan</i> ; and the <i>Community Relations Management Plan</i> .
6.9 The ESIA mentions that there is a lack of settlements (inhabitants) along the Barama Road to the Project and in the area of the new access road. The ESIA needs to include additional documentation/information to justify this statement (dated photographs, survey reports, etc.). This, to be able to contend potential future compensation/resettlement claims or future claims of impacts from traffic on small villages (noise, pedestrian safety, etc.).	Apart from GGI’s temporary support facilities at Tapir Crossing, there are no settlements or habitations between the end of the M30 road and the GGI-constructed extension to Tapir Crossing, or from Tapir Crossing on to the Aurora site. This observation is supported by the fact that the road is travelled daily by GGI staff, and the entire length of the extension was surveyed as part of a right-of-way revegetation project in 2012. Occasional sightings of transient individuals or small groups engaged in artisanal or small-scale mining (ASM) do occur, all of which are reported to GGI management for monitoring purposes. The <i>Transportation Management Plan</i> prepared for the Project requires that all such observations be formally reported, which may, depending on circumstances, prompt additional action and intervention under the <i>Influx Management Plan</i> and/or <i>Community Relations Management Plan</i> .	See Section 5 of the updated ESIA, as well as the initial iterations of the <i>Transportation Management Plan</i> , <i>Influx Management Plan</i> , and <i>Community Relations Management Plan</i> in Appendix 7B .
6.10 A cost-benefit analysis of the Project needs to be included in the ESIA as well as an economic valuation of the environmental and social impacts of the “with project” and “without project” scenario.	Section 3 and Table 3.0-1 of the updated ESIA includes an alternatives and cost-benefit analysis that is reflected in the selected design options described in (TetraTech, 2013).	See ESIA Section 3 and Table 3.0-1 in the updated ESIA.
6.11 The ESIA mentions several high or medium potential social impacts that will be mitigated to low. However, it is difficult to determine what the mitigation efforts will be to reduce these impacts. For example, the impact of upgrading the road will create influx, with the mitigation proposed including careful logistics planning. However, this is not addressed within the Management Plans in any detail. Also, no additional information is included on what policies should the contractors follow (besides the hiring in Georgetown). Further, regarding influx, Section 1.1 identifies 3 “hotspots” but no details are provided in the Management Plans on how to keep people from entering (pouring) into these areas.	The final ESIA identifies residual and cumulative impacts, and provide summaries of the environmental and social impact mitigation measures that will be employed as the Project enters the construction and operations phases (see Section 6). Appropriate cross-references will be provided to specific elements of the overarching Project-specific <i>ESMS Plan</i> . A suite of management plans has been developed to address all significant environmental and social impact areas anticipated for the construction phase, and additional planning documents are slated to be developed under the ESMS as the Project moves into the operational phase. Influx issues are specially addressed in the <i>Influx Management Plan</i> and <i>Community Relations Management Plan</i> , both of which may be informed by information derived from other areas of the ESMS. All ESMS documents will be kept current with the needs of the Project via documented change management processes defined by the <i>ESMS Plan</i> .	See Section 6 and Tables 6.2-1 and 6.3-1 in the updated ESIA; see also ESIA Appendix 7A (the Project) <i>ESMS Plan</i> ; Appendix 7B , which contains initial iterations of all construction-phase management plans; and Appendix 7C , which contains a suite of SOPs designed to support the planning documents included in Appendices 7A and 7B .
6.12 There are some typos in the Table summarizing the CD expenditure to date – the numbers should be written 1,000.00 – there should be a decimals (as opposed to a comma) in the figure. The figures seem unreasonably high otherwise.	Tabular data presented in (TetraTech, 2013) and the updated ESIA have been reviewed for typographical errors and quality assurance purposes prior to submittal.	Not applicable.

7. Comments on the E&S Management Plan Section		
IFC Comment	Comment Response	FS/ESIA Location References
7.1 As mentioned above, the ESMP Section of the ESIA provides several mitigation measures specific to the design of the Project to be able to address the most significant impacts. This includes the installation of liners and secondary containment systems, leak detection systems, the need for more specific erosion control measures and drainage control, ARD characterization and management, tailings design, compliance with the International Cyanide Management Code, among others. It is critical that these recommendations be included in the design of the Project, the final Feasibility Study Report and the revised ESIA.	GGI concurs with the recommendation and directed the preparers of (TetraTech, 2013) to specifically consider the mitigation measures suggested in the original ESIA, to the extent appropriate for the final footprint of the Project and selected design alternatives.	See Section 20 and Table 20-1 of (TetraTech, 2013) and Section 6 and Tables 6.2-1 and 6.3-1 of the updated ESIA.
7.2 As a general comment, there is a need for the Environmental and Social Management Plans – ESMP Section (and the Appendix section) to go into more detail on the mitigation measures and implementation strategies to be adopted by the Project to address the impacts predicted. It is understood that this is dependent on the level of detail that is provided on the engineering side and, therefore, the updated Feasibility Study shall address these issues.	GGI has developed an ESMS based on PS 1 that is embodied in an overarching <i>ESMS Plan</i> . A suite of management plans has been developed, within the context of the ESMS, to address all significant environmental and social impact areas anticipated for the construction phase, and additional planning documents are slated to be developed under the ESMS as the Project moves into the operational phase. The initial versions of these management plans will be informed by the preliminary design information contained in (TetraTech, 2013). They will be periodically updated to keep pace with the needs of the Project via the change management processes defined by the <i>ESMS Plan</i> , and will be further supported by detailed SOPs.	See Section 6 and Tables 6.2-1 and 6.3-1 in the updated ESIA; see also ESIA Appendix 7A , the Project <i>ESMS Plan</i> ; Appendix 7B , which contains initial iterations of all construction-phase management plans; and Appendix 7C , which contains a suite of SOPs designed to support the planning documents included in Appendices 7A and 7B .
7.3 In order to provide more guidance to the Company on the development of their Environmental and Social Management System (ESMS), it is recommended that significantly more detail be included regarding the structure of this ESMS, including the necessary elements, components, programs and plans which will form part of it. Currently, what is listed in the ESMP Section includes: ✓ Policy Framework ✓ Organizational Structure and Responsibilities ✓ Monitoring and Audit Process ✓ Change Management and ✓ Reporting and Disclosure. Together with providing more detail on the above components, it is strongly recommended that several other components of the 4 main elements of the continuous improvement model - <i>plan-do-check-act</i> - be included such as: ✓ Planning Element (Legal Requirements, Hazard Assessment and Risk Management, Objectives and Targets); ✓ Implementation Element (Competency Training, Document Control and Records, Incident Investigation and Analysis, Operational control [<u>key</u>], Emergency Readiness); ✓ Assessment Element (Non-conformance, Measuring and Monitoring, Auditing); ✓ Improvement Element (Management Review).	The ESMS approach presented in the original ESIA has been revised to fully address that January 2012 version of PS 1. In addition to the requirements of IFC Performance Standard 1, <i>ESMS Plan</i> contents also consider applicable elements of: • (IFC, 2007a), (IFC, 2007b), and other IFC Performance Standards, Guidelines, and GIIPs as referenced therein; • the ISO 14001 environmental management system standard, and • the OHSAS 18001 occupational health and safety (OHS) management system standard. These standards have been widely and successfully applied by the international mining industry, and collectively represent an appropriate basis for an effective, continuous-improvement (i.e., “plan-do-check-act”) based, and fully integrated ESMS that addresses applicable Guyanese regulatory requirements as well as international norms for the management of mining project operations.	In the updated ESIA, see Appendix 7A , the Project <i>ESMS Plan</i> ; Appendix 7B , which contains initial iterations of all construction-phase management plans; and Appendix 7C , which contains a suite of SOPs designed to support the planning documents included in Appendices 7A and 7B .

7. Comments on the E&S Management Plan Section		
IFC Comment	Comment Response	FS/ESIA Location References
7.4 The ESIA also needs to indicate that the construction contractor for the Project shall develop its own E&S Management System aligned with the Company's ESMS and that this system shall be in place before construction starts.	The PS 1-based <i>ESMS Plan</i> developed for the Project will include specific provisions for communication of environmental, occupational health and safety, and other social requirements (which may include compliance with one or several elements of the Project ESMS) to contractors via their contracts or procurement documents. The level of rigor of these requirements will be commensurate with the range of services provided. Contractor compliance with such requirements will be periodically evaluated through one or more of the inspection and auditing features of the ESMS.	See Section 7 of this updated ESIA, as well as Appendix 7A , <i>ESMS Plan</i> , Section 4.3.3, "Control of Contractor Operations"
7.5 Following the revision and enhancement of the ESMP section as indicated above, IFC agrees with the statement on Page 10-1 of the ESIA that Guyana Gold shall develop specific management plans and procedures (Contractor Management Plans - CMPs) based on the contents of the ESMP Section of the ESIA. It is important also to indicate in the ESIA that the Contractor responsible for construction shall develop its own E&S Implementation Plans (ESIPs) based on the CMPs developed by Guyana Gold.	See above; GGI will require that the engineer/procure/construct (EPC) contractor develop a <i>Construction Management Plan – Major Construction</i> within the context of the ESMS that is designed specifically to address the major construction phase of the Project. The <i>Construction Management Plan-Major Construction</i> will define minimum requirements for contractor quality, environmental, and health and safety programs, as well as policies for labour management and interaction with local residents that are consistent with the goals of the Project ESMS and governing regulations.	See Section 7.2.2 of this updated ESIA, as well as Appendix 7A , <i>ESMS Plan</i> , Section 4.3.3, "Control of Contractor Operations"
7.6 As two EIAs have been prepared for the Project (one for the Government of Guyana, submitted in June 2009 and one to meet IFC standards prepared in May 2010), a cross check is needed between the local EIA and the final IFC-compliant ESIA (especially to the ESMP section) to identify any inconsistencies or contradictions which could create regulatory/compliance conflicts down the road. An example would be mandatory [in the views of the government] mitigation measures or commitments based on Project designs which have been updated or modified.	Once all necessary approvals on this updated ESIA have been secured, GGI will negotiate an appropriate modification to the Environmental Permit to assure full consistency between the updated ESIA and specific permit conditions.	See Table 1.2-1 of this updated ESIA.

1.4 Organization of ESIA Report

The contents of the remaining sections of this updated ESIA are briefly summarized in the flowing paragraphs:

- **Front Matter:** The front matter of this updated ESIA contains a revision history document control log; a statement of limitations and the signature of ENVIRON's Managing Principal; a master table of contents (TOC); a master acronyms list; and a concise Executive Summary. It should be noted that where individual sections have a significant number of subheadings, section-specific TOCs have been provided for the convenience of the reader.
- **Section 2: Project Description:** Section 2 is consistent with the latest iteration of the Project design as presented in (TetraTech, 2013); it summarizes the physical and geological setting of the Project as well as the layout of major Project features. It also discusses the major activities that will take place in each phase of Project activity.
- **Section 3: Alternatives Assessment:** This section provides a comparison of major Project alternatives that were evaluated in the development of the consolidated Project design represented in TetraTech (2013).
- **Section 4: Updated Environmental Baseline:** This Section presents an update to the environmental baseline originally developed as part of the ERM (2010) ESIA. Section 4 contains the results of a number of additional environmental field studies conducted in 2011 and 2012 and addresses independent review comments provided by the University of Guyana Centre for the Study of Biological Diversity (CBSD, 2013).
- **Section 5: Updated Socioeconomic Baseline:** This Section presents an update to the environmental baseline originally developed as part of the (ERM, 2010) ESIA, and integrates the results of additional public consultation meetings in the communities of Aranka Mouth and Buckhall and other related data gathering activities conducted in 2011 and 2012.
- **Section 6: Impact Assessment:** Section 6 builds on the presentation and assessment of impacts originally conducted in ERM (2010) and updated in Table 20-1 of TetraTech (2013). **Tables 6.2-1 and 6.3-1** present, respectively, a cumulative assessment of impacts and a preliminary identification of mitigation measures for those impacts determined to be significant.
- **Section 7: Social and Environmental Assessment and Management System (Ref: IFC PS 1):** IFC PS 1 has been determined to be applicable to the Project, and Section 7 presents the overall design and contents of the PS 1-based Environmental and Social Management System (ESMS) that will be implemented during the entire mine life cycle.
- **Section 8: Labor and Working Conditions (Ref: IFC PS 2):** IFC PS 2 also applies to the Project, and Section 8 summarizes the approach used by GGI to achieve

compliance with IFC labor and working condition requirements on the part of its workforce and supply chain.

- **Section 9: Resource Efficiency and Pollution Prevention (Ref: IFC PS 3):** IFC PS 3 applies to the design, construction, operation, and decommissioning and closure of the Project. Section 9 addresses the Project's approach to the management of water, power, and other resources, and addresses the prevention, minimization, and management of pollution sources associated with key Project components.
- **Section 10: Community Health, Safety, and Security (Ref: IFC PS 4):** IFC PS 5 applies to all phases of the Project, and Section 10 presents the Project's approach to the protection of the health, safety, and security of the two small communities affected by the Project, as well as the GGI and contractor workforce.
- **Section 11: Land Acquisition and Involuntary Resettlement (Ref IFC PS 5):** IFC PS 5 has been determined to be not applicable to the Project as no land acquisition or involuntary resettlement conditions exist. Section 11 provides justification for this determination.
- **Section 12: Biodiversity Conservation and Sustainable Natural Resource Management (Ref: IFC PS-6):** PS 6 has been determined to be applicable to the Project. Section 12 summarizes the Project's approach to the protection and conservation of biodiversity, including the introduction of practical and achievable offsets to achieve a "no net loss" goal for natural habitat.
- **Section 13: Indigenous Peoples (Ref: IFC PS-7):** PS 7 has been determined to be not applicable to the Project; Section 13 provides justification for this determination.
- **Section 14: Cultural Heritage (Ref: IFC PS-8):** PS 8 has been determined to be not applicable to the Project, and Section 14 provides justification for this determination.
- **Section 15: Master References List:** This section contains a master list of references for the entire main text of the updated ESIA document.

Thirteen supporting appendices are also included in the updated ESIA, the contents of which are briefly described in the following paragraphs. Please note that numerical designators are keyed to the specific sections of the ESIA that the Appendices are primarily intended to support.

- **Appendix 2A: Aurora Gold Project – Selected Preliminary Design Drawings:** This Appendix contains a series of preliminary design drawings that are consistent with the design presented in TetraTech (2013) and provide general descriptions of the major infrastructure elements of the Project.
- **Appendix 4A: Bio-Assessment of the Cuyuni River near Aurora, Guyana, Environmental and Economic Implications, October 2009:** This Appendix contains the full text of the noted report prepared by Dr. Nicole Duplaix in 2009, which examines

the negative baseline impacts of water quality degradation from uncontrolled artisanal and small-scale mining (ASM) in the Cuyuni River basin on the abundance of large faunal species in the area of the Aurora Gold Project.

- **Appendix 5A: Example of Questionnaire Used for Gathering Updated Social Baseline Data:** This Appendix provides an example of the questionnaires used to gather data for the updated social baseline study summarized in Section 5 of the updated ESIA.
- **Appendix 5B: Notes from Public Consultation and Information Disclosure Site Visits, 2012:** The documents in this Appendix support the data gathering actions completed as part of the updated social baseline study summarized in Section 5 of the updated ESIA. Notes and contact records are included from an additional round of public meetings conducted by GGI in 2012 specifically to engage the communities of Buckhall and Aranka Mouth.
- **Appendix 7A: Environmental and Social Management System Plan (ENVIRON):** This Appendix contains the full text of the overarching *Environmental and Social Management System Plan (ESMS Plan)* that guides the implementation of the comprehensive ESMS prepared for the Project pursuant to the requirements IFC PS 1.
- **Appendix 7B: Management Plans (ENVIRON):** This Appendix contains the full texts of the first iterations of 14 discrete management plans developed to manage several of the environmental and social impacts associated with the full construction phase of the Aurora Gold Project.
- **Appendix 7C: Standard Operating Procedures (ENVIRON):** This Appendix contains an initial suite of 44 SOPs guiding standard practices associated with the management of environmental and social impacts and the implementation of the management plans discussed in Appendix 7B, as well as the ESMS Plan included in Appendix 7A.
- **Appendix 9A: Geochemical Testing Reports (KCB):** This Appendix presents the results of three separate studies conducted to evaluate the geochemistry of the ore body and mine tailings, with emphasis on the potential for generation of acid rock drainage (ARD) conditions. The Appendix consists of the full texts of the following reports:
 - “An Investigation into Geochemical and Geotechnical Characterisation of Guyana Goldfields Mine Tailings” (SGS Canada, 2010);
 - “Aurora Gold Project – Static Acid Rock Drainage and Metal Leaching (ARD/ML) Interpretation” [Klohn Crippen Berger (KCB), 2012a]; and
 - “Aurora Gold Project – Acid Rock Drainage and Metal Leaching Characterization-Kinetic Test Results” (KCB, 2012b).
- **Appendix 9B – Hydrogeology/Groundwater Inflow Study (Itasca):** This Appendix consists of the full text of “*Predictions of Groundwater Inflow to Sublevel Retreat Mining*

at Guyana Goldfields' Aurora Mine, Guyana, South America" (Itasca, 2013). The report presents the results a three-dimensional (3-D) finite element modeling exercise conducted to predict groundwater inflows into the proposed open pits and underground workings of the Aurora Gold Project.

- **Appendix 9C: Water Quality Study Report (ENVIRON):** Appendix 9C presents the results of a water quality monitoring study conducted by ENVIRON that examines the fate and transport of selected environmental contaminants in (and at some specific points in mine life discharged from) the TMA and MWP, under normal operating conditions. The study used Visual MODFLOW and EFDC models to evaluate surface water and groundwater impacts for representative contaminants over the life of the mine.
- **Appendix 9D: Report from Independent Review of Tailings Management Area (TMA) Design:** This Appendix documents the results of an independent review commissioned by GGI that examines the overall adequacy of the conceptual design of the TMA.
- **Appendix 14A, Archaeological Baseline Study Report:** this Appendix contains the archaeological baseline study commissioned for the Project, which is documented in "Technical Report Identifying the Potential Range of Cultural Resources with the Aurora Gold Mining Project Area, Guyana" (Plew, 2012).

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Section 2:
Project Description

Contents

	Page
2 Project Description	2-1
2.1 Project Setting	2-1
2.1.1 Geographical and Geological Setting	2-1
2.1.2 Environmental Setting	2-6
2.1.3 Social Setting	2-6
2.2 Early Works Construction Phase	2-9
2.3 Major Construction Phase	2-9
2.3.1 Cuyuni River Dike Construction, Airstrip Renovation, and Open Pit Area Clearances	2-9
2.3.2 Mine Waste Rock Stockpile Footprint Preparation	2-12
2.3.3 Mill Area Infrastructure Construction	2-12
2.3.4 Tailings and Reclaim Pipeline and Initial Tail Mining Area (TMA) Clearance and Construction	2-14
2.3.5 MWP and Fresh Water Pond (FWP) Clearance and Construction	2-15
2.3.6 Underground Mine Construction	2-15
2.3.7 Man-Camp Completion	2-15
2.3.8 Decommissioning and Closure of Tapir Camp	2-16
2.3.9 Final Construction Activities, Buckhall	2-16
2.4 Operational Phase	2-17
2.4.1 Power Generation	2-17
2.4.2 Open Pit Mining Operations	2-17
2.4.3 Underground Mining Operations	2-18
2.4.4 Mineral Processing Operations	2-20
2.5 Decommissioning, Reclamation, and Closure Phase	2-23
2.6 Post-closure Phase	2-29

List of Tables

Table 2.1.3.2-1: Estimated Life of Mine Staffing Levels – Aurora Gold Project

List of Figures

- Figure 2.1-1: Aurora Gold Project – Aurora Mine Site Plan
- Figure 2.1-2: Mineralized Zones in the “Golden Square Mile”
- Figure 2.1-3: Local and Regional Geology, Aurora Gold Project
- Figure 2.1-3: Local and Regional Geology, Aurora Gold Project (Source: GGI)
- Figure 2.1-4: 3-D Visualization of Mineralized Zones In relation to Conceptual Pit Boundaries
- Figure 2.2-1: Fuelling Trestle, Buckhall Logistics Support Facility
- Figure 2.2-2: New Administrative Buildings, Buckhall Logistics Support Facility
- Figure 2.2-3: Revegetated ROW Areas, Aurora M3 Road Extension – Example of Red Baromalli Tree Plantation
- Figure 2.2-4: New Modular Man-camp Under Construction, Aurora Site (2012)
- Figure 2.4-1: Conceptual View of Underground Mine
- Figure 2.4-2: Conceptual Plan View of Representative Sublevel in Underground Mine
- Figure 2.4-3: Conceptual Process Flow Sheet, Aurora Gold Project

Figure 2.4-4: Conceptual Model of Aurora Gold Project Water Balance

Figure 2.5-1: Project Configuration at Closure

2 Project Description

The following paragraphs provide an overall description of the Aurora Gold Project (Project), including a summary of its geographical, geological, environmental, and social setting, as well as summarized descriptions of the major features and activities of the Project over all of the phases that comprise the mine life cycle (i.e., early works construction, major construction, operations, decommissioning/closure, and post-closure). The design assumptions reflected in Section 2 and other sections of this updated Environmental and Social Impact Assessment (ESIA) are based primarily on the latest Project feasibility study (FS), “NI 43-101 Technical Report: Updated Feasibility Study, Aurora Gold Project, Guyana, South America” (TetraTech, 2013) and other supporting studies conducted on behalf of Guyana Goldfields, Inc. (GGI). The preliminary design reflected in TetraTech (2013) will be developed and finalized in conjunction with the initiation of the major construction phase of the project. It is understood that as part of the final engineering design process, GGI may require additional engineering or technical studies to support certain aspects of the final design.

2.1 Project Setting

The geographical, geological, environmental, and social setting of the Project is summarized in the following paragraphs, based on the latest available NI 43-101 report (TetraTech, 2013), other sections of this updated ESIA, and other references as noted.

2.1.1 Geographical and Geological Setting

The Project is located in a remote, forested, and largely uninhabited area of northwestern Guyana (see **Figures 1.1-1, 1.1-2, and 1.1-3**). As noted in these figures, the Project is comprised of four major components:

- the **Aurora mine site**, located at latitude 6°45'N, longitude 59°45'W, on the southern bank of the Cuyuni River approximately 170 kilometers (km) west of Georgetown, and within the boundaries of an approved 5,802 hectare (ha) A1 Mining License (ML) area (see **Figure 1.1-3** and the overall site plan shown in **Figure 2.1-1**);
- the **Buckhall** river port and logistics support facility, on the west bank of the Essequibo River as shown in **Figure 1.1-2**;
- the **Barama (M3) Road**, which was built in the 1990s to provide access to a large hardwood timber concession north of the Cuyuni River owned by Barama Company Ltd., and for which GGI has negotiated a shared usage arrangement; and
- the **Aurora M3 road extension**, built in 2011-2012, a new 33 km road constructed by GGI which connects the end of the Barama Road with Tapir Crossing (a vehicle barge ferry landing on the Cuyuni River) and extends from Tapir Crossing due west to the Aurora mine site.

The greatest concentration of mineral resources at the Aurora site, as reported in (TetraTech, 2013), occur within an approximately 2 km long corridor within GGI's A1 Mining License area, which has been referred to colloquially as the “Golden Square Mile”; see **Figure 2.1-2**.

Figure 2.1-1: Aurora Gold Project – Aurora Mine Site Plan (Source: Appendix 2A, TetraTech DWG-C0105, Rev A)

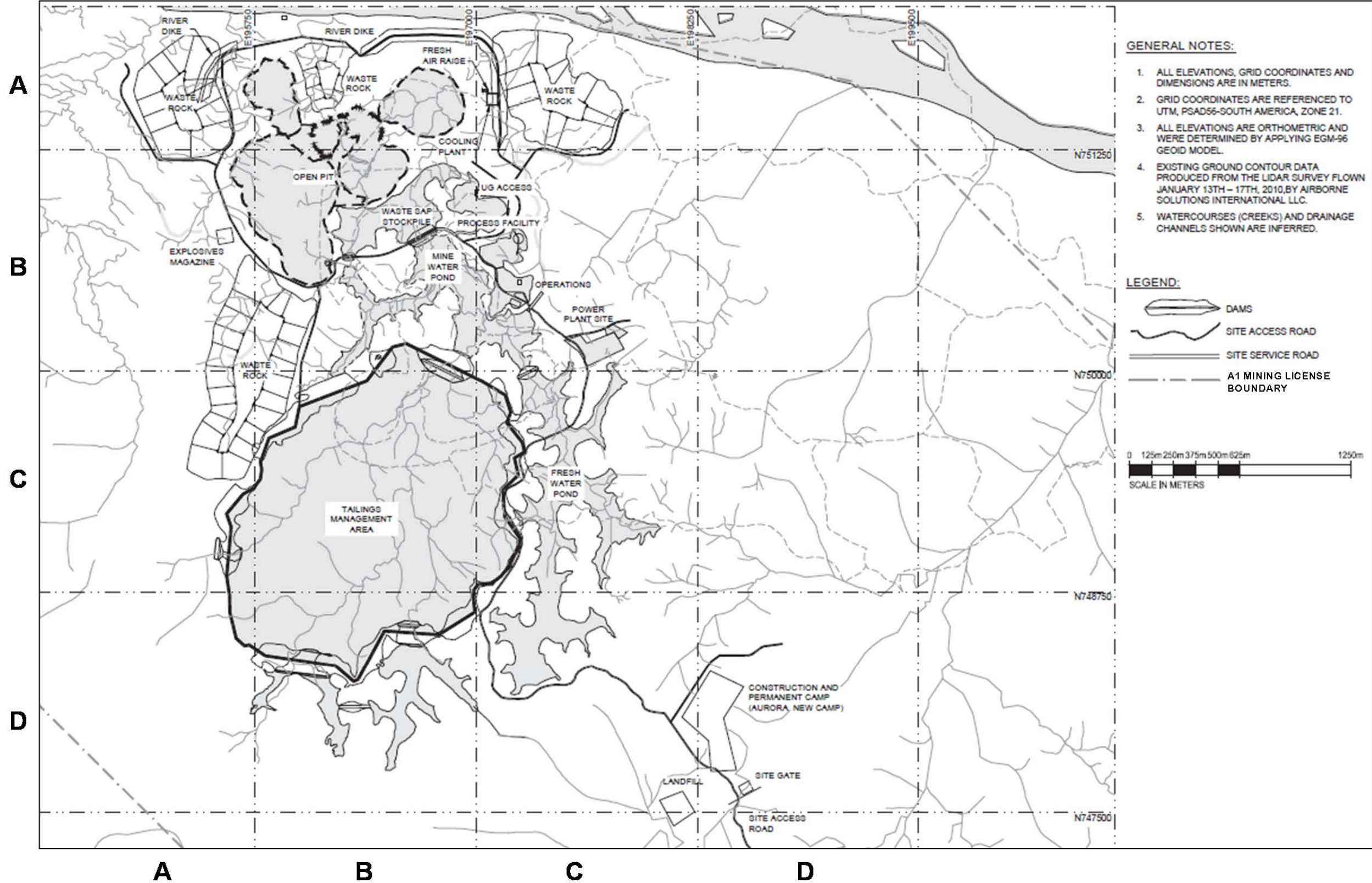


Figure 2.1-2: Mineralized Zones in the Golden Square Mile (Source: GGI)

As described in greater detail in Section 4.7, the Project is located in the Guiana Shield, a palaeo-Proterozoic granite-greenstone terrane that is considered to be the extension of the West African palaeo-Proterozoic Birimian Supergroup terrane, which hosts a number of significant gold mining properties (e.g., present-day southern Ghana). The Guiana Shield is the northern Amazon Craton, which was part of the West African Craton until the Atlantic Ocean opened about 115 million years ago. The Amazon Craton is divided into geological provinces based on age determinations, structural trends, proportions of lithologies and geophysical trends. The Proterozoic greenstone areas of Guiana are in the Pastora-Amapa Province [2.2 to 1.95 billion years and consist of metavolcanic and metasedimentary rocks. Tropical weathering has transformed the upper, approximately 100 meters (m) of the Guiana Shield into a layer of saprolite, some areas of which have sufficient mineralization to be considered ore-grade material. The mineral resources in the Golden Square Mile occur primarily in folded metasedimentary and metavolcanic rock that has been metamorphosed to greenschist assemblages. As depicted in **Figure 2.1-3**, the Golden Square Mile area is located within a broad regional, northwest trending, high strain zone characterized by strong northwest trending and subvertical foliation and dip slip shearing (southwest over northeast) and strain partitioning into an interconnected network of discrete shear zones that control gold mineralization (TetraTech, 2013).

Mineral resources are reported at two cut-off grades [see Table 1-1 of (TetraTech, 2013)] to reflect the fact that parts of the gold mineralization are more suitable for open pit extraction methods, while other mineralized areas are generally of higher grade and are therefore more amenable for extraction via underground mining methods. **Figure 2.1-4** provides a 3-D visualization of the mineralized zones in relation to the projected boundaries of the open pit areas. The deep mineralized zone beneath Rory's Knoll (shown in dark blue in **Figure 2.1-4**) will be developed as an underground mine.

Figure 2.1-3: Local and Regional Geology, Aurora Gold Project (Source: GGI)

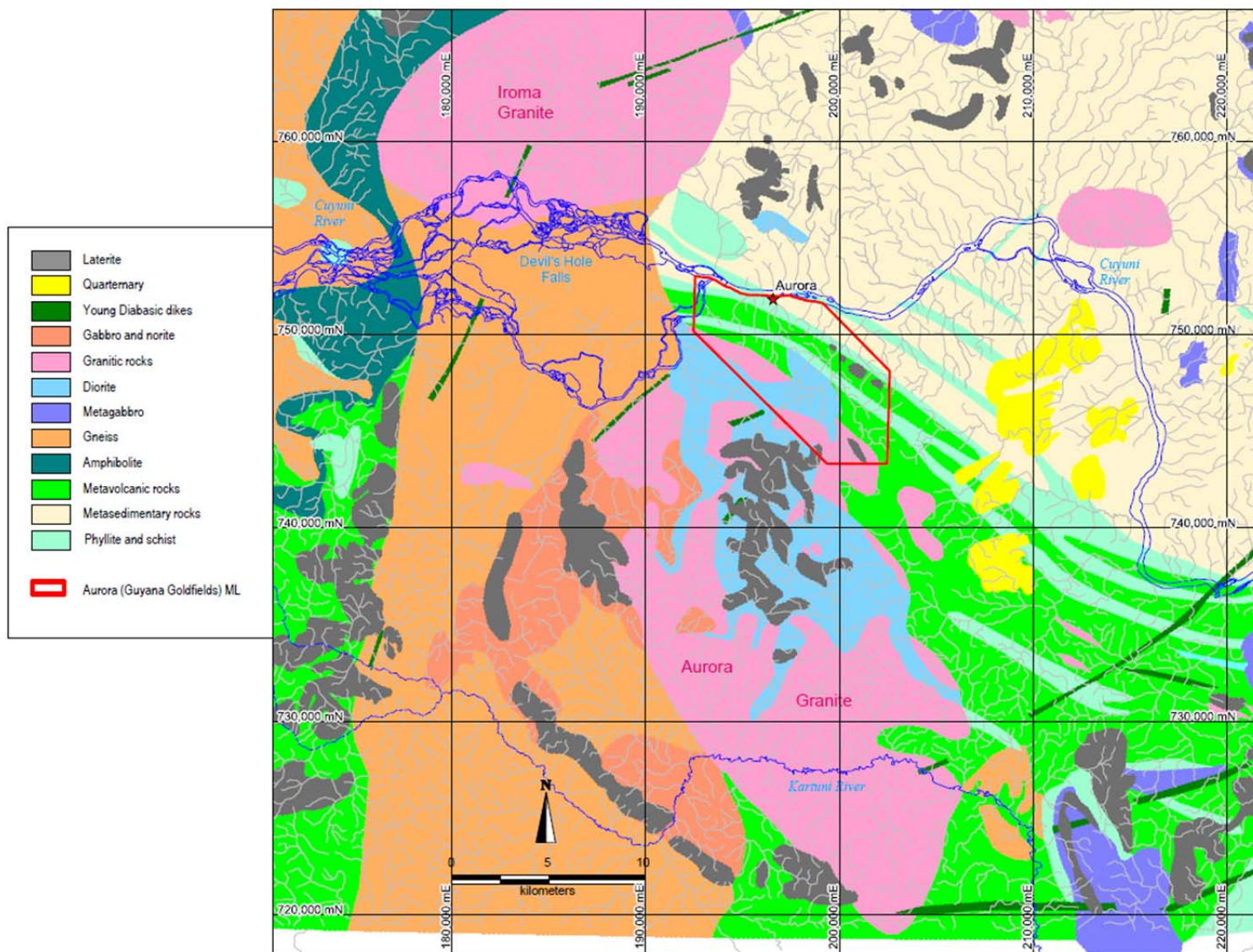
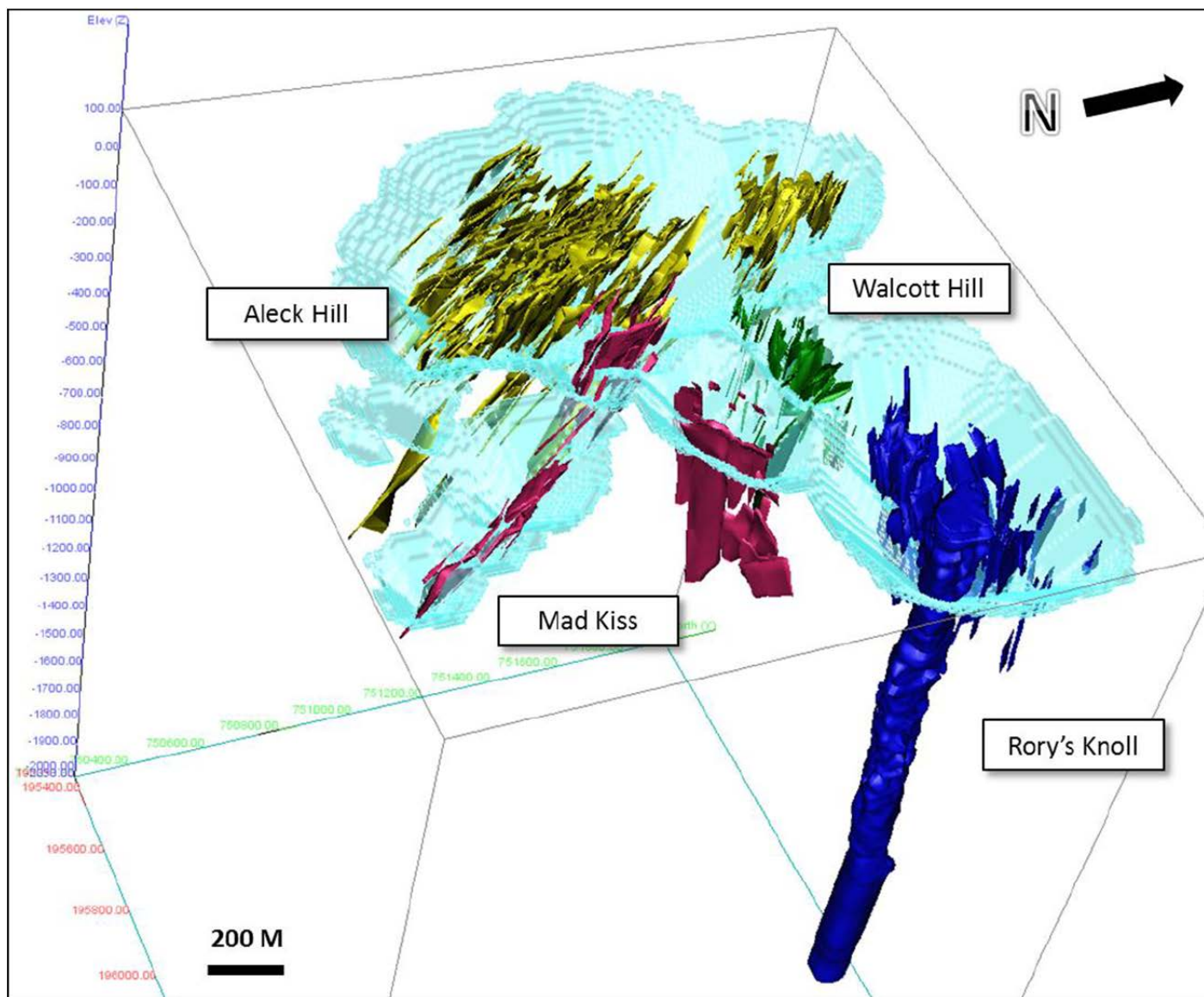


Figure 2.1-4: 3-D Visualization of Mineralized Zones In relation to Conceptual Pit Boundaries [Source: (TetraTech, 2013)]



2.1.2 Environmental Setting

As noted in Section 1.1, a number of studies were conducted in the area of the Project from 2006 through 2012 by several teams of national and international biologists, ecologists, and social scientists. These studies collectively confirm that contrary to initial visual impressions, the environment associated with the Project's primary components [i.e., the Buckhall logistics support facility, the Barama (M3) road, the M3 road extension to the Aurora site, and the Aurora mine site proper] is not a primary forest but has been significantly impacted by artisanal and small-scale mining (ASM), logging, hunting, and other intrusive human activities for well over a century. The area immediately surrounding the Aurora site was first explored in the 1930s and 1940s, and has been impacted by ASM activities ever since. It has been observed that large faunal species otherwise common in relatively pristine habitats along similar types of rivers in this part of South America are absent or very rare in the area of the Project. This may be regarded as a key indicator of historical human impact, presumably due to the pressures of hunting and the increased turbidity and general degradation of river quality from many years of logging and ASM activities, as well as from the continuing disturbances created by motorized equipment and sporadic motorboat and roadway traffic.¹ Apart from supporting a major logging concession (operated by Barama Company Limited since the early 1990's), construction of the Barama Road has also contributed to a significant increase in human activities in the region to the north of the Cuyuni River and to the west of the Essequibo River. However, both of these rivers have long served as transportation corridors since the prehistoric arrival of the first indigenous peoples, and more so with the advent of motorized river craft and the boom in ASM prompted by high gold prices.

For the purposes of this updated ESIA, the Project's primary environmental area of influence (AOI) is understood to be comprised of the footprint of the mining operation at the Aurora site with a nominal 0.5 km buffer zone around the perimeter of the operation, plus a 0.5 km buffer zone on either side of the Aurora (M3) road extension as illustrated in **Figure 1.1-3**. As noted in **Figure 1.1-2**, the Project also shares an AOI with Barama Company Ltd. between the end of the Aurora (M3) extension and Buckhall.

Detailed discussion of biology and biodiversity, climate, and air and water quality in and near the Project's environmental AOI are presented in Section 4 of this updated ESIA.

2.1.3 Social Setting

2.1.3.1 Area of Influence and Affected Communities

As described in ERM (2010) and elaborated in Section 5 of this updated ESIA, the Project is set in a remote and sparsely populated area. There are no communities in the immediate area of the Project's A1 ML or environmental AOI (see **Figures 1.1-1 and 1.1-2**). Two informal communities are considered to be in the Project's direct (social) area of influence (DAI); these are:

¹ A major source of the degradation is in the Cuyuni headwaters in Venezuela, where extensive small scale saprolite mining for gold has been underway for decades.

- **Aranka Mouth**, an informal settlement engaged primarily in ASM, located on the north bank of the Cuyuni River approximately 16 km downstream from the Aurora site, and approximately 10 km due north of the Aurora (M3) road extension; and
- **Buckhall**, an informal community at the eastern end of the Barama (M3) Road, due adjacent to (due north) GGI's secure logistics facility of the same name. The Buckhall community is on the western bank of the Essequibo River, due south of the Barama Company Ltd. timber concession, with residents engaged primarily in logging, ASM, and light commerce.

The Project's environmental AOI does not encroach on (nor is it adjacent to) any titled Amerindian lands or lands frequented by Amerindians. As noted in Section 13 and **Figures 13.2-1 and 13.2-1**, the nearest Amerindian community is Kurutuku, approximately 40 km upstream from the Aurora site on the Cuyuni River.

Although remote and heavily forested, the Project AOI has at various times been traversed or investigated by groups or individuals engaged in ASM, hunting, and other intrusive human activities for many years. However, as discussed in Section 11.3, no legal or illegal ASM operations have been or will be displaced by Project activities. GGI's actions in securing its ML have been conducted in accordance with all applicable Guyanese legal requirements. In addition, it should be noted that the Government of Guyana has, through the granting of the Project's Environmental Permit (Guyana EPA, 2010), required GGI to systematically discourage influx to the Project area, in order to preclude the generation of negative environmental and social impacts that are typically associated with such influx. GGI has addressed this requirement in the preparation of its *Influx Management Plan* and *Community Relations Management Plan* (see **Appendix 7B**).

2.1.3.2 Project Workforce

The Project will operate on a 24 hours per day, 7 days per week schedule, at least 360 days per year. GGI anticipates staffing the Project with a primarily indigenous workforce, with expatriate (Canadian, Australian, and United States) and third-country national roles generally limited to specific management, supervisory, and technical positions. Current estimated staffing levels over the life of the mine are presented in **Table 2.1.3.2-1**.

It should be noted that all Guyanese nationals will be eligible for retrenchment compensation as the result of predicted workforce reductions at the end of the Project's approximately 20-year life², in keeping with the requirements of applicable Guyanese labor laws. Contingency funding to address this obligation is included in GGI's initial mine reclamation and closure cost estimate; see the initial version of the *Mine Reclamation and Closure Plan* in **Appendix 7B**.

² Per (TetraTech, 2013), mine life will be comprised of 1-2 years of construction, followed by 17 years of open pit and underground mining, followed by approximately 1 year of decommissioning and closure activities. The proposed post-closure period is nominally 2 years.

Table 2.1.3.2-1: Estimated Life of Mine Staffing Levels – Aurora Gold Project (Source: GGI)

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
*Expat	1	25	25	25	25	25	25	25	25	28
**TCN	5	9	9	9	9	46	46	46	46	41
Local	198	282	298	298	286	405	405	405	405	406
Total	204	316	332	332	320	476	476	476	476	475

Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
*Expat	41	41	37	37	37	37	37	37	37	37
**TCN	28	28	4	0	0	0	0	0	0	0
Local	406	337	337	340	340	340	340	340	340	340
Total	475	406	378	377	377	377	377	377	377	377

* Canadian, Australian, or US nationals

**Third-country nationals

2.2 Early Works Construction Phase

As of the submittal date of this updated ESIA, the Project may be understood as currently being in its “early works” construction phase, which is focused on those activities that do not require the authorization and completion of a highly detailed final design effort, or the performance of complex construction activities. Early works construction phase Project activities conducted in 2011, 2012, and early 2013 were concentrated primarily on the development of basic infrastructure at the Buckhall logistics support facility (see **Figures 2.2-1 and 2.2-2** for examples) and the construction of the Aurora (M3) road extension.

Other work in this time period included the reclamation of a number of areas of over-cleared rights of way (ROWS) on the new M3 road extension (See **Figure 2.2-3**), and the development of a new, modular man-camp at the Aurora site (see **Figure 2.2-4**) to replace and supplement the older exploration phase camp facilities (see the foreground of **Figure 2.1-2**) that will be displaced by projected mining activities.

2.3 Major Construction Phase

The major construction phase of the Project is expected to be generally characterized by the activities noted in the following paragraphs.

2.3.1 Cuyuni River Dike Construction, Airstrip Renovation, and Open Pit Area Clearances

Two saprolite earthfill river dikes (see zones AA, AB, and AC in **Figure 2.1-1**) will be constructed in two locations alongside the Cuyuni River in order to mitigate potential flood risks to the open pit and underground mining areas. The dikes will be designed for extreme flood and earthquake criteria [i.e., a 1-in-10,000-year flood level and the maximum credible earthquake (MCE)]. The combined length of the dikes will be about 1,500 m, with a 5-m wide gravel road on the crest of each. A series of relief wells and a rip-rap filled toe drain will be installed on the pit side of the dikes to manage the phreatic surface and potential seepage. Once the dikes are completed, the side slopes will be revegetated for erosion control purposes. The existing airstrip (not shown in **Figure 2.1-1**, but visible in the lower right of **Figure 2.1-2**) lies between the area of the two dikes and the southern bank of the Cuyuni River, and will be regraded and resurfaced as necessary after completion of dike construction. The upgraded airstrip will consist of a 15-m wide crowned gravel surface, flanked by 7.5 m cleared ROW areas and drainage channels.

Figure 2.2-1: Fuelling Trestle, Buckhall Logistics Support Facility



Figure 2.2-2: New Administrative Buildings, Buckhall Logistics Support Facility



Figure 2.2-3: Revegetated ROW Areas, Aurora M3 Road Extension; Example of Red Baromalli Tree Plantings (Source: GGI)



Figure 2.2-4: New Modular Man-Camp Under Construction, Aurora Site (2012)



Initial ground surface clearances will be made for the Rory's Knoll pit and associated haul roads, as noted in zone AB of **Figure 2.3-1**, in order to expedite mining access to the Rory's Knoll underground deposit. Once the Rory's knoll pit is fully developed, the remaining pit areas (i.e., the Aleck Hill, Aleck Hill North, Mad Kiss, and Walcott Hill pits) will be cleared and developed simultaneously with the underground operation. Topsoil will be reserved in stockpiles located as close as possible to the waste rock stockpile areas. The latter will be progressively revegetated in the operational and closure phases of the Project.

2.3.2 Mine Waste Rock Stockpile Footprint Preparation

Waste rock will be placed in four sequentially constructed stockpiles near the perimeters of the open pits as noted in **Figure 2.1-1**; one additional stockpile will be constructed for waste (non-ore grade) saprolite, as also shown in zone BB. The Rory's Knoll waste rock stockpile will be developed first (zone AC), followed by the waste saprolite stockpile and the two waste rock stockpiles located in zones AA and AB. The last (and largest) waste rock stockpile will be developed due west of the Mine Water Pond (MWP). Each stockpile will be progressively reclaimed when it reaches its design height in the operational phase as discussed in Section 2.5.

The footprint area for the Rory's Knoll except for the saprolite stockpile area will be cleared in the construction phase of the Project, with topsoil separately reserved for future progressive reclamation efforts. As noted in Section 4.7.3 and **Appendix 9A**, results of geochemical testing indicate that acid rock drainage (ARD) conditions are not likely to be generated in any of the waste rock stockpiles, with some limited potential associated with one specific area of saprolite (see **Appendix 9A**). Perimeter drains will nevertheless be installed around the footprint of each prepared stockpile pad, and routed to the MWP or to dedicated settling ponds for additional dilution or treatment, as necessary, prior to controlled discharge to the environment. Monitoring wells will be installed upgradient of all projected sedimentation pond locations (see DWG-N0100 (**Appendix 2A**)). Soils in the footprint areas are expected to be predominantly saprolite with naturally low permeability; cleared footprint areas will be inspected and amended as necessary by local compaction or the placement of compacted clay in areas with exposed bedrock.

2.3.3 Mill Area Infrastructure Construction

Major elements of infrastructure in the mill area will be built in the construction phase of the project. The overall preliminary design layout of the mill area is depicted in DWG-C0108 and DWG-C0106 (see **Appendix 2A**). Major construction features are described in the following paragraphs.

- **Crushing Circuit:** a three-stage (one jaw crusher, one secondary cone crusher, and two tertiary cone crushers) crushing circuit will be constructed as shown in DWG-C0108, along with conveyor systems and a run of mine (ROM) ore pad area. As noted in Section 2.3.2, results of geochemical testing indicate that ARD conditions are not likely to be generated in any ROM ore except for one specific type of saprolite as noted in **Appendix 9A**. Drains will still be installed downgradient of the ROM pad, however, and runoff routed to the MWP for settling and dilution. Soil in the ROM footprint area is

expected to be predominantly saprolite with naturally low permeability. The pad area will be inspected and amended as necessary prior to any ore placement.

- **Mill:** two ball mills will be installed on a concrete foundation under a roofed enclosure adjacent to the processing plant. One mill will be installed in the construction phase; installation of the second ball mill will occur in the operational phase as necessary to support the increased throughput needs required by Phase 2 of the mining effort.
- **Process Plant:** because the Project will employ a cyanide-based mineral extraction process, the process plant will be designed to incorporate specific International Cyanide Management Code (ICMC) requirements for secondary containment, materials selection, and workplace health and safety (e.g., ventilation, safety showers, fire extinguisher locations, hydrogen cyanide monitors, pH meters). Equipment layouts in the final design will consider the proper separation of potentially incompatible materials (e.g., cyanide solution and strong acids). Coated concrete foundations and secondary containments will be constructed, but no roofing will be required over major tank areas. Secondary containment arrangements will be provided with means for the periodic evacuation of accumulated precipitation. Concrete cyanide mixing aprons³, solution storage tanks, a clarifier, two leach tanks, a series of six carbon in leach (CIL) tanks, elution columns, carbon regeneration kilns, two cyanide detoxification tanks, an enclosed gold room with electrowinning cells and gold doré furnace, an enclosed operational control room, and all interconnecting piping, electrical, and control systems will all be constructed.

In keeping with ICMC guidelines, process plant secondary containment volumes will be capable of containment of 110% of the maximum working volume of the largest contained tank, plus potential piping system flowback volumes, plus contingency for the potential volume associated with a 24-hour, 100-year precipitation event. In addition, a double-lined emergency discharge pond will be located immediately west of the process facility that will provide an additional 2,000 m³ containment capacity.

- **Power Plant and Power Distribution Lines:** as noted in DWG-E0102 (see **Appendix 2A**) the power plant site and access roadways will be cleared and will initially require construction of a 1M liter steel bulk storage tank for No. 4 generator fuel, with concrete foundations and secondary containments; associated fuel offloading facilities; generator and electrical equipment foundations; and three 3.5 MW No. 4 fuel fired generator sets. Up to five additional generator sets and potentially one more 1M liter No. 4 fuel tank may be installed in the operational phase of the Project. Overhead distribution lines and transformers will be installed as shown in DWG-E0100 (see **Appendix 2A**).
- **Fuel Storage:** access roadways and pad areas for the ready line and fuel farm will be cleared; diesel fuel for mobile and stationary equipment will be stored in five 62,000-liter

³ Cyanide will be delivered in stainless steel delivery containers as discussed in Section 10.3.1; no separate mixing facilities will need to be constructed, but in-delivery tank mixing activities will need to take place on appropriately designed concrete containment aprons that drain to the primary secondary containment areas of the process plant.

double-walled modular tanks as shown in DWG-M0102, along with lubricant tanks and offloading and dispensing equipment (with appropriate secondary containment/spill prevention and control equipment). The fuel offloading, storage, and dispensing area will be provided with a canopy roof and will be underlain with a 40 millimeter high-density polyethylene (HDPE) liner draining to appropriately designed spill collection sumps that permit product recovery.

- **Warehouse, Laboratory, Operations and Maintenance Offices, Maintenance Shop, Canteen, and Other Ancillary Facilities:** adjacent to the access roadways, pad areas will be cleared for construction of heavy and light vehicle maintenance shops, warehouses, offices, laboratory, canteen, and other ancillary facility areas as shown in DWG-C-0106 (see **Appendix 2A**). Shop and warehouse foundations will typically be slab on grade, with containment provided for chemical storage areas and spill collection drains and oily water separators installed at the vehicle maintenance shops. A rooftop rainwater harvesting system, 40,000-gallon raw water tank, and modular potable water filtration/treatment system and potable water supply tank will be installed. Sanitary waste from the canteen, office, and shop areas will be collected and piped to a modular sewage treatment system that will be built east of the operations and maintenance facility. Secure explosives storage magazines and blasting agent silos will be built and licensed with the Guyana Geology and Mines Commission (GGMC) and Guyana Police Force (GPF).

2.3.4 Tailings and Reclaim Pipeline and Initial Tail Mining Area (TMA) Clearance and Construction

The overall layout of the TMA is presented in DWG-C0112, DWG-C0116, and DWG-C0117 (see **Appendix 2A**). In the construction phase, an HDPE tailings pipeline and reclaim water return pipeline will be constructed between the detoxification circuit at the process plant and the TMA. Although (because of the anticipated efficiency of the detoxification process) cyanide concentrations in the tailings are projected to be <0.5 milligrams per liter (mg/L) WAD_{CN} [i.e., below the IFC (2007) and ICMC discharge limits for cyanide], appropriate pipeline spill capture features (e.g., lined trench arrangements or emergency collection ponds) will be included as part of the final design, for those areas of the pipeline that would not naturally drain to the TMA basin. The TMA footprint area will be cleared, with topsoil reserved for use in progressive restoration. The cleared basin will be inspected for bedrock outcrops or other geological features that could potentially represent a source of channeling or excessive seepage in the constructed facility. Any suspect areas will be amended by placement of compacted clay or other appropriate methods, as necessary to ensure generally uniform hydraulic conductivity across the basin area. A core trench will then be excavated and starter dam constructed of compacted sapolite, as shown in DWG-C0116. As noted in DWG-C0117, the TMA starter dam and each successive raise are designed with internal drains; appropriate seepage collection and pumped return systems for each phase of construction will be developed as part of the final design. Two additional sapolite dams (TMA Diversion Dams 1 and 2) will also be built to intercept the runoff from an approximately 225 ha watershed located to the south of the TMA.

One monitoring well will be installed downstream of the starter dam, as shown on DWG-N0100 in **Appendix 2A**. Two additional monitoring wells and two surface water sampling stations will be established downgradient of the TMA diversion ponds.

2.3.5 MWP and Fresh Water Pond (FWP) Clearance and Construction

In the construction phase of the Project, the MWP and FWP basins footprint areas (see DWG-C0114 and DWG-C0113 (see **Appendix 2A**) will be cleared, with topsoil reserved for use in progressive restoration. The cleared basins will be inspected for bedrock outcrops or other geological features that could potentially represent a source of channeling or excessive seepage in the constructed facilities. Any suspect areas will be amended by placement of compacted clay or other appropriate methods, as necessary to ensure generally uniform hydraulic conductivity across the basin area. A saprolite dam (designed in general accordance with the typical cross section provided as DWG-C0118) and a spillway will be constructed at the northern edge of the FWP, discharging into the MWP. Additional spillway drawings will be developed as part of the detailed design effort. A core trench will be excavated for the construction of a similar saprolite dam for the MWP, also in general accordance with typical cross section provide by DWG-C0118. As noted in DWG-C0118, the MWP and FWP dams are both designed with chimney, blanket, and toe drains; appropriate seepage collection and pumped return systems for each dam will be developed as part of the final design. In addition, the WMP will be provided with a rip-rap armoured, overflow spillway, as shown in DWG-C0119 and DWG-C0119.

One monitoring well will be installed downstream of the MWP dam and spillway, as shown on DWG-N0100 in **Appendix 2A**.

Two additional raises of the TMA will be required in the operations phase of the Project; see Section 2.4.4 for a summary of related construction activities.

2.3.6 Underground Mine Construction

Construction of the underground mine portal and advancement of a spiral access decline and associated ventilation raises is expected to commence approximately two years prior to the cessation of open pit operations (i.e., well into the operational phase of the Project). See Section 2.4.2 for a description of the underground mine and mining operations. The underground mine will be designed to include underground explosives magazines, secure firing systems, ventilation and dewatering systems, light-repair mechanical workshops (with suitable spill containments and oily water separators), workrooms/offices, first aid stations, communications/control centers, utility distribution equipment, and other infrastructure.

2.3.7 Man-Camp Completion

Construction activities at the Aurora site man-camp will be completed, and will include final construction and commissioning of the following facilities:

- security guardhouse, fencing, and vehicle barriers;
- all required modular housing units, for the workforce, supervisors, and managers;
- canteen and food storage areas;

- recreation center;
- medical clinic/infirmary;
- laundry facilities;
- a 1.3. ha lined raw water surface catchment, 400,000-gallon raw water supply tank, and connecting pipelines;
- modular self-contained potable water treatment plant and 120,000-gallon potable water storage tank;
- primary and backup sanitary wastewater treatment lagoons and modular wastewater treatment plants;
- fire water storage suppression system, pump station and pipelines connecting to the raw water supply tank;
- vehicle parking areas; and
- a licensed solid waste landfill (see **Table 1.2-1**).

2.3.8 Decommissioning and Closure of Tapir Camp

Except for a security guardhouse on the northern bank of the Cuyuni River at Tapir Crossing, the temporary man-camp and exploration/early works construction phase support facilities at Tapir will be decommissioned. The site generator, salvageable buildings, materials, and equipment will be removed to the Aurora site. Remaining structures or unsalvageable materials will be demolished and removed to landfill areas. Existing landfill areas will be covered and the site regraded and revegetated with native species. Support for Tapir Crossing (e.g., security staff, ferry barge operators, boat operators, fuelling services) during the late construction and operational phases of the Project will be provided on an ongoing basis from the Aurora site.

2.3.9 Final Construction Activities, Buckhall

Construction activities at the Buckhall logistics center will be completed, and (see drawing DWG-C0103 in **Appendix 2A**) will include final construction and commissioning of:

- the wharf area;
- the customs yard, office, and warehouse;
- additional worker accommodations, with a combination water well/rooftop collection system sourced potable water treatment system and a sanitary wastewater treatment plant;
- laydown and convoy marshaling areas;
- fuelling stations and vehicle maintenance facilities, with appropriate spill containment, oily water separator, and fire suppression arrangements;
- a 1M liter diesel tank and 2M liter No. 4 fuel tank, connected to the existing fuel trestle and fuel pipeline, and also with appropriate secondary containment and oily water separator arrangements; and

- a licensed solid waste landfill (see Table 1.2-1) and secure hazardous waste storage facility (to be fabricated from a steel intermodal container).

All of these facilities will be located within the existing security fence boundary, as noted in DWG-C0103 (see **Appendix 2A**).

2.4 Operational Phase

Major activities in the operations phase of the project are presented in the following paragraphs.

2.4.1 Power Generation

Electrical power will be provided by a series of 3.5 MW No. 4 fuel-fired generator sets (gensets). Three gensets will be installed in the construction phase of the project. Up to five additional gensets may be required to meet the power demands of the underground operations and the full throughput required by Phase 2 of the mining effort. No. 4 fuel (a blend of diesel and No 6 heavy fuel oil) was selected as a compromise between higher cost diesel fuel and heavy fuel oil, which is difficult to transport and handle and generates significantly greater air emissions. As noted in TetraTech (2013), GGI may consider additional studies to examine other power generation alternatives, including consideration of a biomass power plant to be installed at Buckhall or at the Aurora site, or conventional (No. 4 fuel-fired) power generation, with a transmission like to the Aurora site.

2.4.2 Open Pit Mining Operations

Because of its low strip ratio, the Rory's Knoll open pit will be mined first. Near-surface saprolite and fresh rock ore deposits will be mined and access developed to the underground deposits noted in **Figure 2.1-4** as early in the operational phase as possible.

Mining operations will be conducted around the clock, 365 days per year unless delays are caused by extreme weather events or other unusual conditions. Blasting operations are expected to be conducted by a specialty contractor who will manage blasting magazines and blasting agent silos, and will provide downhole delivery services. Blasting agents will include water resistant emulsion, with some potential for ammonium nitrate/fuel oil (ANFO) products in dry zones.

As noted in TetraTech (2013), open pit mine design is based on a conventional surface mine operation using 152 millimeter (mm) blast holes, front end loaders for ore and waste loading, and haulage by a fleet of 43.5 tonne capacity trucks. The ultimate pit design incorporates pit slope geometries (i.e., the bench face angle, inter ramp angles, and berm widths) for the various rock types and pit sectors, includes haulage ramps, and takes into account minimum mining width based on the mining equipment selected. The open pit design was completed for five areas:

- Rory's Knoll;
- Aleck Hill;
- Aleck Hill North;
- Mad Kiss; and

- Walcott Hill.

Mining of the latter four pits is planned to be generally in parallel after the Rory's Knoll pit has reached its design depth and underground operations are under way (approximately 8 years after the start of open pit mining at Rory's Knoll).

Precipitation, roadway runoff, and groundwater inflow into the pit areas from the pit highwalls will be collected from all pits and pumped to surface sumps located near the rim of the pit, from which it will be pumped to the MWP for settling and dilution. Pumping infrastructure will advance with the active mining as it advances deeper into each pit, and will continue until Project completion and decommissioning/closure of the underground mine.

2.4.3 Underground Mining Operations

As previously noted, construction of the underground mine portal and advancement of a spiral access decline and accompanying ventilation/emergency egress raises is expected to commence approximately two years prior to the cessation of open pit operations, in order to ensure a consistent ROM ore source for mill processing. The mine is designed to exploit the Rory's Knoll deposit from about 75 m below sea level (mbsl) to approximately 970 mbsl, as described in Section 16 of TetraTech (2013). As currently conceived, the mine portal will be constructed on the southern edge of the ROM stockpile pad at about 75 m above sea level (masl). See **Figures 2.4-1 and 2.4-2** for plan and representative section views of the underground mine.

The mine is designed to use a combination of open benching (for the first six sublevels) followed by the sublevel retreat (SLR) mining method for all remaining sublevels. As noted in the alternative discussion in Section 3, the SLR method was selected as a preferred alternative for most of the underground operation because it represented the lowest cost option with manageable risks, maintenance of a safe mining environment, and achievement of desired production rates. It also eliminates the need for paste backfill using tailings and associated infrastructure, which was a feature of the blast hole open stoping (BHOS) method considered in the previous NI 43-101 report (SRK, 2012).

Figure 2.4-1: Conceptual View of Underground Mine [Source: (TetraTech, 2013)]

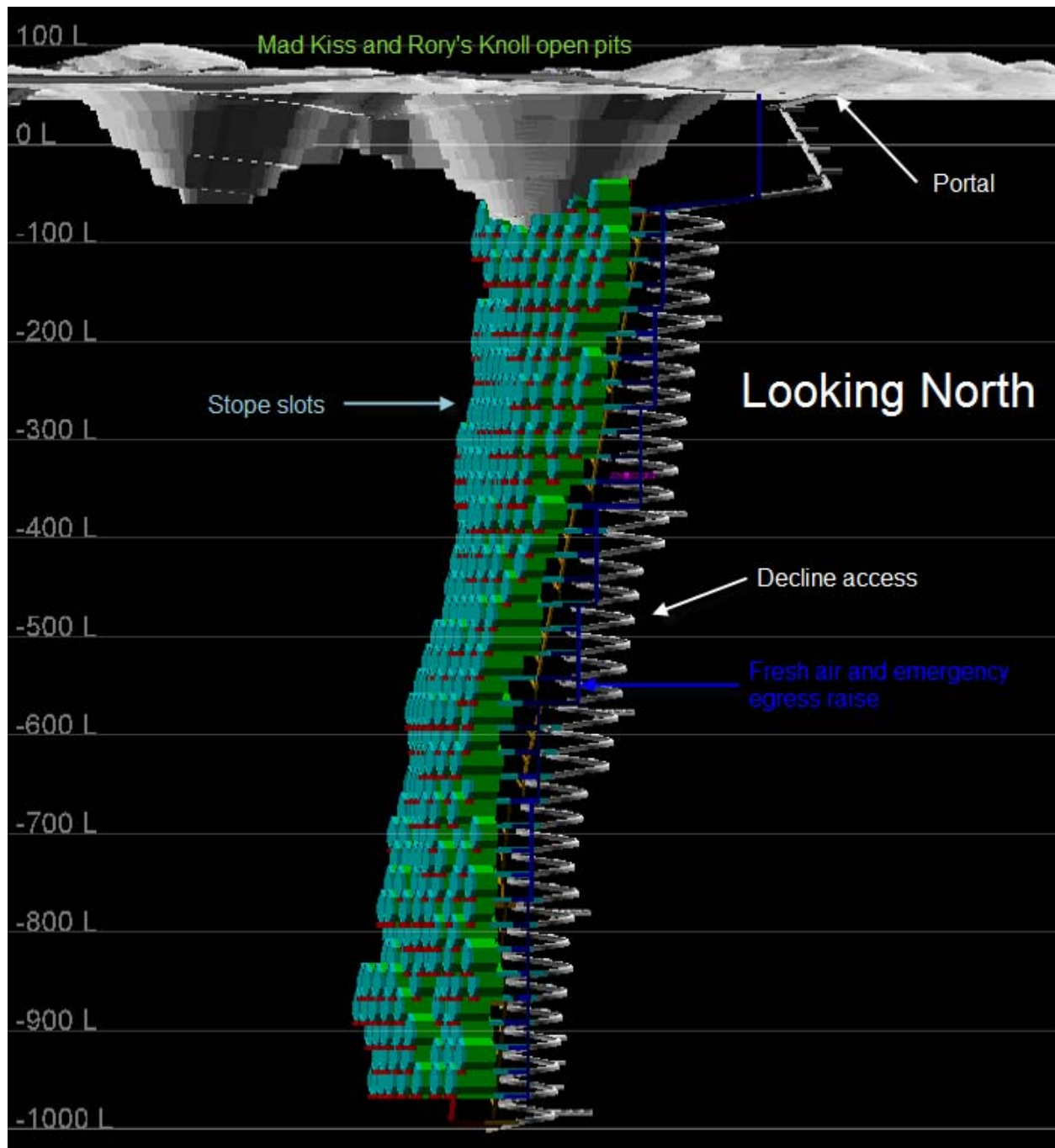
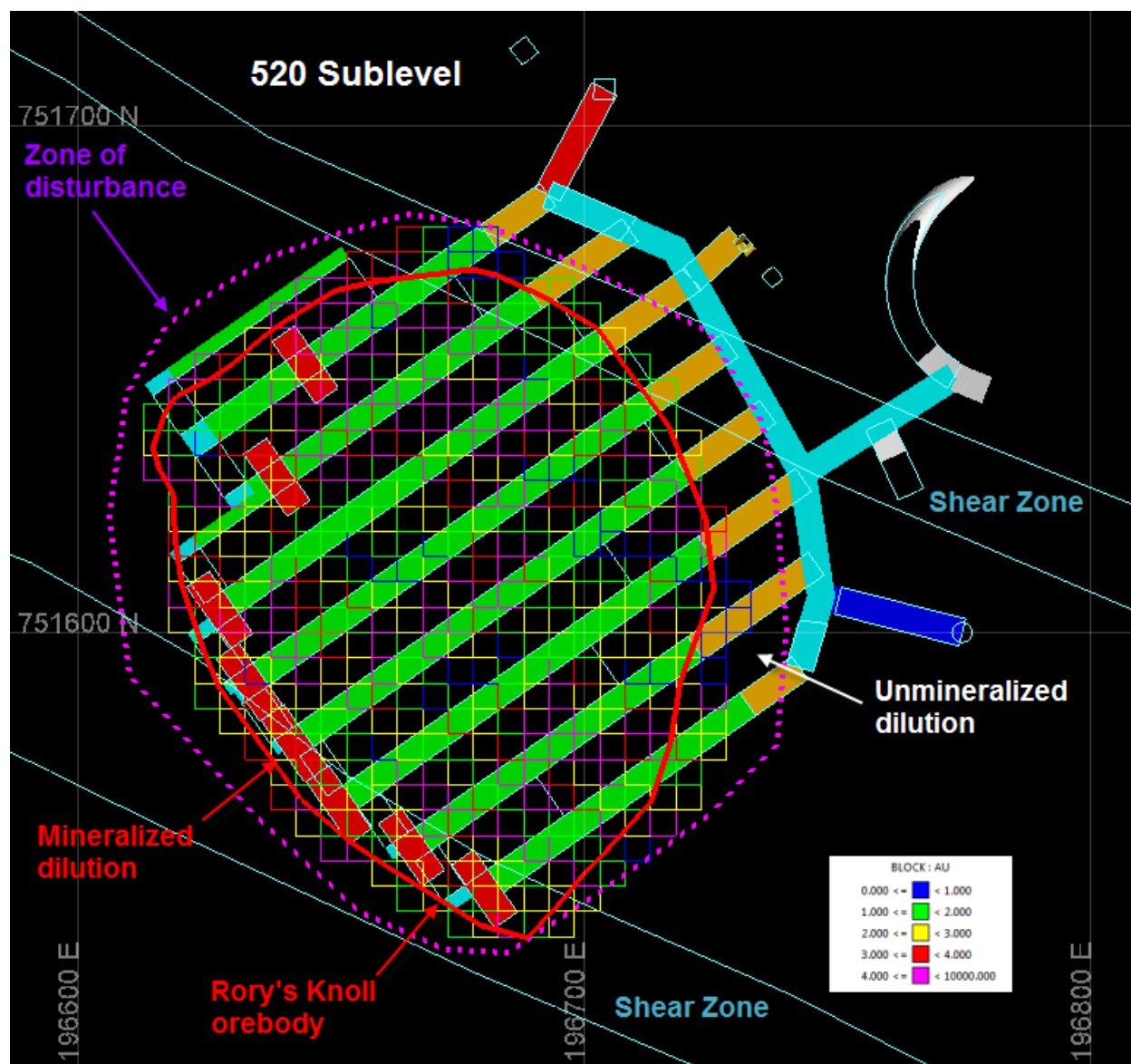


Figure 2.4-2: Conceptual Plan View of Representative Sublevel in Underground Mine
 [Source: (TetraTech, 2013)]



Based on the production grade assumptions presented in TetraTech (2013), after a 2-year construction and preproduction period, the Rory's Knoll underground mine is expected to be operated for approximately 13.5 years.

2.4.4 Mineral Processing Operations

The overall strategy for mineral processing presented in TetraTech (2013) is to design and construct efficient, safe, and robust processing facilities that will permit optimal mineral recovery using standard proven designs, processes, equipment, instrumentation, and good international industry practices (GIIPs). Measures to minimize the potential risks to the GGI workforce, the public, and the environment will be designed into each step of the mining and milling process,

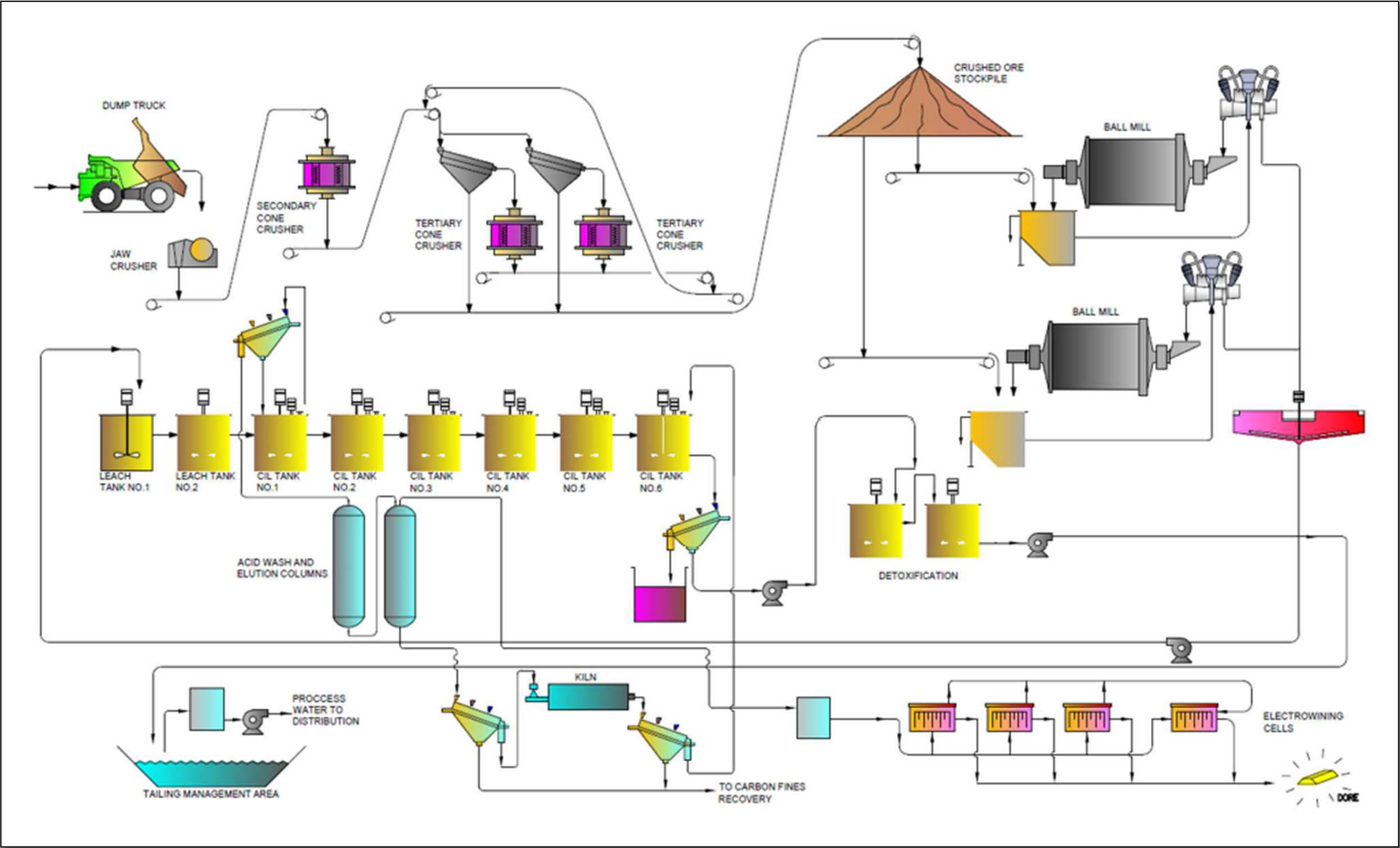
as noted in Section 6 of this updated ESIA. An overall schematic of mineral processing operations is provided in **Figure 2.4-3**. Major steps in the process are further described as follows:

- **Ore Crushing, Milling, and Grinding:** The ore will be crushed to a millable size using a three-stage crushing operation. Three separate ore types will be processed: saprolite, open pit fresh rock, and underground fresh rock. Phase 1 of the mineral processing operation will consist of crushing followed by a single ball mill grinding circuit providing an operating capacity of 5,000 kilograms per day (kg/d). Phase 2 incorporates a second ball mill installed in parallel to the Phase 1 ball mill and increases operating capacity to 10,000 kg/d.
- **Mineral Separation:** the mill and mineral separation facility is designed to treat a nominal 1.75 million tonnes per annum (Mt/a) during Phase I and 3.5 Mt/a after Phase 2. All three ore types (saprolite, pit fresh rock, and underground fresh rock) are amenable to conventional cyanide leaching. The milling plant will have overhead cranes and a roof. The gold leaching process will use a modified CIL circuit for leaching and doré recovery. Fresh Rock will be crushed prior to the single stage ball mill grinding section followed by thickening, leaching, CIL treatment, carbon desorption, and eluate electrowinning. The Saprolite will be processed in conjunction with Fresh Rock whenever available. Upon the depletion of the Saprolite ore, the process facility will begin treating 100% fresh rock.

Gold doré (an amalgam of gold and a small percentage of silver) bullion will be produced in the on-site refinery and stored in a secure vault prior to transportation to an off-site precious metals separation refinery.

- **Tailings Detoxification Operations:** all processes will be treated using an air/SO₂ cyanide detoxification system prior to tailings disposal. This system will be operated to achieve a nominal weak acid dissociable (WAD) cyanide concentration of 0.5 mg/L in the tailing stream as it enters the tailings pipeline and is deposited in the TMA. Based on design details provided in an early FS (SRK, 2012), the detoxification facility will be designed with parallel treatment loops that ensure no loss of detoxification efficiency if part of the circuit needs to be taken offline for maintenance or repair purposes.

Figure 2.4-3: Conceptual Process Flow Sheet, Aurora Gold Project (Source: GGI)



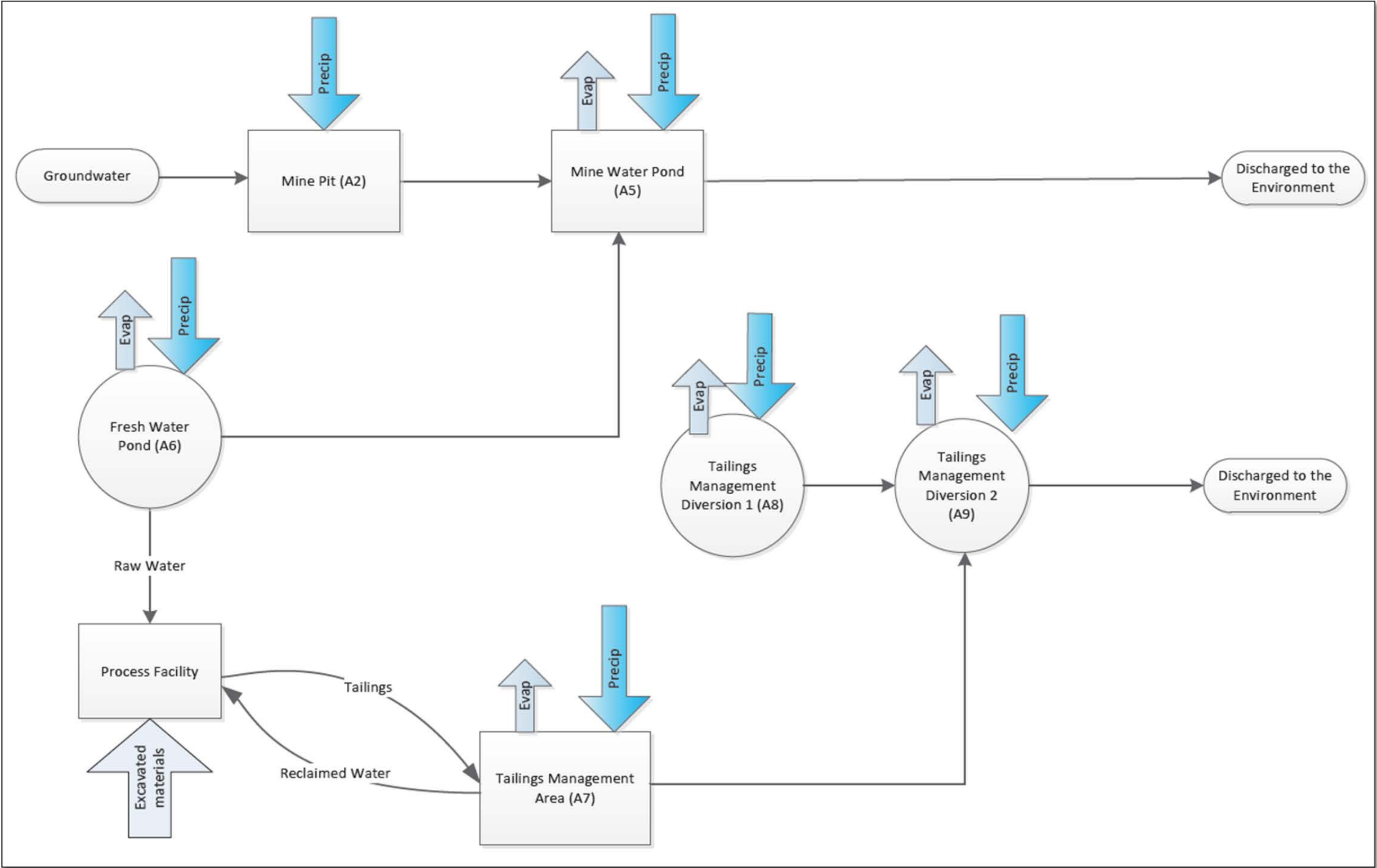
- **TMA Operations:** as previously noted, detoxified tailings (i.e., tailings with a nominal WAD_{CN} concentration of 0.5 mg/L) will be deposited in the TMA via a dedicated tailings slurry pipeline, and reclaim water will be pumped back to the process facility from a reclaim pond barge for industrial use in the mill complex. In the operational phase, the main tailings dam and a small saddle dike will be constructed in two major raises at the north end of the TMA, as noted in DWG-C0116. The TMA will also be equipped with a two-level spillway, which will be raised along with each dam raise. The low-flow spillway is designed to provide the required retention time. The high-flow spillway is set to provide 0.5 m of freeboard above the probable maximum flood (PMF) level. The final TMA dam crest will be at 75 m elevation with the low-flow spillway at 73 m and the high-flow spillway at 74 m elevation. As noted in DWG-C0117, the main TMA dam is designed with internal drains; appropriate seepage collection and pumped return systems will be developed as part of the final design.

As discussed in Section 20.2 of TetraTech (2013) initial site water balance modeling results have indicated a strongly positive water balance that will require an ability to make periodic controlled discharges to the environment; see **Figure 2.4-4** for a conceptual model of the site water balance. The TMA has therefore been designed to provide a minimum retention time of 30 days for all accumulated runoff and tailings supernatant water prior to any potential discharge, assuming mean annual precipitation conditions. Over the first four years of operation, the mixing ratio for tailings water and precipitation within the TMA capture area is estimated to be 1:9 during an average year. Any water discharged from the TMA spillway will flow into the pond at TMA Diversion Dam 2 and be further diluted prior to entering the environment. As noted in DWG-N0100, a monitoring well has been located downgradient of the discharge point from TMA Diversion Dam 2. If necessary, an additional sedimentation or polishing pond can also be installed to provide additional dilution or treatment capability.

2.5 Decommissioning, Reclamation, and Closure Phase

Current estimates of mine life indicate that mining operations will cease approximately 18 years after the start of open pit mining operations, although it must be emphasized that the actual length of mine life will be determined by actual recoveries, commodity price performance, and other factors. When mining ceases, the final stockpile of ROM ore will be processed, and the Project will enter a period of decommissioning and closure. GGI has already developed a conceptual *Mine Reclamation and Closure Plan* for the Project (see **Appendix 7B**), which will be issued and implemented within the context of the Project ESMS, as discussed in Section 7, and periodically updated over the life of the mine. In addition to predicted final closure actions, the *Mine Reclamation and Closure Plan* addresses progressive and interim closure actions; specific actions to minimize the attractiveness of the closed site for any future ASM incursions; workforce retrenchment considerations; and post-closure inspection and monitoring. Two years prior to the anticipated end of mine life, a detailed version of this document (referred to as the *Detailed Mine Reclamation and Closure Plan*) must be prepared and submitted to the Guyana Environmental Protection Agency (Guyana EPA) for review and approval. It is expected that the *Detailed Mine Reclamation and Closure Plan* will fully define requirements for post-closing monitoring.

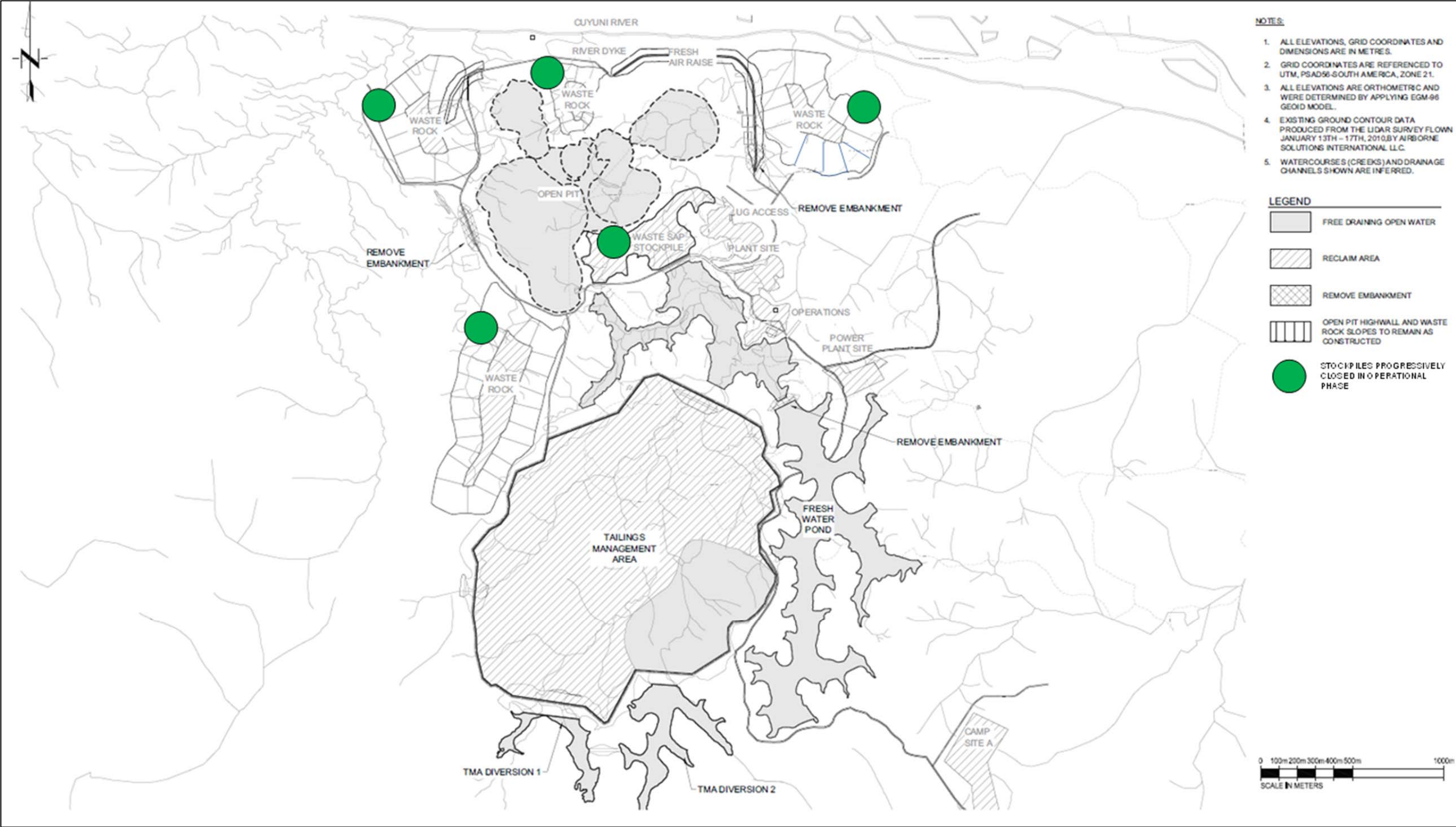
Figure 2.4-2: Conceptual Model of Aurora Gold Project Water Balance [Source: (TetraTech, 2013)]



Ownership of the Project airstrip, the Aurora (M3) road extension to the end of the Barama Road, the ferry landings at Tapir Crossing, and the Buckhall river port and logistics center is expected to revert to the Government of Guyana at the end of mine life. The *Mine Reclamation and Closure Plan* is therefore concentrated on the decommissioning and closure of primary elements of infrastructure at the Aurora mine and mineral processing operations site and man-camp (see **Figure 2.5-1**); these include:

- all open pit mining areas, and a new outlet to the Cuyuni River established for the interconnected pit lakes;
- the Cuyuni River dikes;
- the underground mine and associated adits, airshafts, support facilities and underground infrastructure;
- waste rock/saprolite stockpiles (to be progressively closed during the operations phase);
- the ROM ore stockpile;
- the diesel power plant, power distribution substation, and transmission lines;
- the fuel storage tank farm, secondary containments, and fuelling station;
- the mineral processing plant (including ore sorting, crushing, leaching, and cyanide detoxification circuits);
- the TMA and TMA Diversion Ponds 1 and 2;
- the FWP and MWP;
- laydown areas and warehouses;
- mechanical and maintenance shops;
- permitted solid waste landfill;
- hazardous waste storage facility area;
- haul and access roads;
- man-camp and administrative buildings; and
- potable water and septic/wastewater treatment systems.

Figure 2.5-1: Project Configuration at Closure (Source: Appendix 2A, TetraTech DWG-N0102, Rev A)



Unless other land uses, mixtures of land use, or other beneficial uses of specific elements of Project infrastructure are negotiated with the Government of Guyana and other stakeholders, the overall goals for Project decommissioning and closure will be to return the land to a physically, biologically, and chemically stable and ecologically functional condition that approximates baseline conditions. GGI is also obliged, as a condition of its Environmental Permit (Guyana EPA, 2010), to minimize the potential attractiveness of the decommissioned site for illegal or uncontrolled ASM activities. Progressive closure options will therefore be sought, wherever possible in the construction and operational phases of mine life, in an effort to minimize the potential for subsidence and erosion damage, to enhance biodiversity and the restoration of natural habitats, and to minimize the potential attractiveness of the site. These options will include:

- establishment and maintenance of stockpiles of mulch and nurseries stocked with cuttings, seeds, or seedlings of appropriate naturally occurring, fast-growing plant species, to support progressive, interim, and final revegetation needs;
- progressive reclamation and revegetation of access and haul road ROWs and construction borrow areas;
- progressive reclamation and revegetation of areas encountered within the Project concession that may have been damaged by illegal or historical ASM, or other uncontrolled human intrusion;
- progressive placement of soil covers and revegetation of top and bench surfaces of waste rock/saprolite stockpiles, establishment of stable natural drainage channels, and installation of settling ponds at each stockpile, if required for sediment control; and
- periodic removal of used, scrap, or surplus mining equipment or materials from the Project site (e.g., open pit mining equipment at the completion of pit operations; worn-out pumps or piping system components).

In addition, closure actions at the end of mine life will include:

- placement of final soil cover, regrading, and revegetation of the permitted solid waste landfill at the Aurora man-camp;
- selective breaching, modification, and revegetation of the Cuyuni River dikes, and selective breaching, regrading, and revegetation of the FWP, MWP, TMA, and TMA Diversion Pond embankments, as indicated in **Figure 2.5-1**;
- placement of soil cover and revegetation of the dewatered beach areas of the TMA;
- construction of effluent settling, dilution, and/or polishing ponds for the FWP, MWP, TMA, and TMA Diversion Ponds if necessary to ensure consistency of discharged water quality with respect to the IFC (2007) effluent standards;
- development of interconnected pit lakes and a stable natural drainage channel to the Cuyuni River (with a security berm and warning signs established throughout the period of pit lake infilling); and

- controlled closure and abandonment of monitoring wells and piezometers at the end of post-closure monitoring.

The Republic of Guyana does not currently have any permitted hazardous waste disposal facilities; however, it is understood that at least one such facility is in planning, and it is assumed that such a facility will be available for use by GGI at the time of mine closure. It is also noted that Guyana does not currently have any significant metals or other waste materials recycling capabilities. GGI will monitor for the development of such capabilities over the years of mine operation and will update the *Mine Reclamation and Closure Plan* accordingly if viable recycling sources are identified for any of the waste types generated in site decommissioning and closure. However, for the purposes of TetraTech (2013) and this updated ESIA, it is conservatively assumed that no recycling facilities will be available. With these assumptions in mind, decommissioning wastes will be managed as follows:

- Major equipment items expected to have any significant resale value at closure are limited to the crushers, the ferry barges from Tapir Crossing, the TMA reclaim barge, high-value gold room equipment, and a number of the larger pumps.
- Motorized equipment that is operational will be removed from the site and transferred to other GGI operations or sold on the open market as appropriate.
- Non-operational motorized equipment, tanks, pumps, piping systems, and wood, metal, or concrete structures will be decommissioned and demolished. Hazardous materials will be drained or captured and collected in the on-site hazardous waste storage facility until transfer and controlled disposal in a Guyana EPA-approved off-site hazardous waste landfill.
- Decontaminated tanks or equipment will be cut or disassembled into manageable sizes and disposed of in the underground mine or in a special inert waste disposal cell constructed in the final waste rock stockpile. Access to the underground mine after disposal actions are complete will be permanently closed by the installation of engineered plugs in the airshafts and main portal. Waste materials that may be disposed of in the waste rock stockpile inert waste cell will be completely covered with at least a meter of waste rock prior to closure.
- Concrete foundation areas will be razed to ground level, covered with soil, graded, and revegetated. Concrete demolition rubble will be placed in the waste rock stockpile prior to stockpile closure.
- Cyanide facility equipment, tanks, and piping systems will be flushed with rinseate routed to the detoxification plant prior to disposal in the TMA, after which the rinsed detoxification plant and the tailings pipelines will also be demolished and disposed of in the underground mine or in an inert waste cell constructed in the final waste rock stockpile.

Residual hazardous materials (e.g., unused reagents, fuel, lubricants, paints, insecticides, reagents, or explosives) will be returned to suppliers for credit or otherwise sold to properly

licensed or reputable dealers, and strictly for the purposes intended by the manufacturer. Any residual hazardous wastes will be accumulated in the on-site hazardous waste storage facility prior to being routed to an approved off-site hazardous waste landfill; residual medical wastes will be routed to an approved medical waste incinerator in Georgetown.

As noted previously, GGI has lodged an initial Environmental Bond as a condition of receiving its Environmental Permit (Guyana EPA, 2010). In addition, GGI will establish financial surety or assurance instruments in keeping with IFC (2007) requirements in order to cover the estimated cost of closure at any stage in the mine life, including appropriate considerations for any potential early or temporary closure action. Per IFC (2007), funding may be provided by either a cash accrual system, or a financial guarantee provided by a reputable financial institution. If a cash accrual system is used, there are two acceptable cash accrual system alternatives: a fully funded escrow account or a sinking fund. GGI will select an appropriate mechanism that is consistent with these options prior to commencing major construction. Since IFC (2007) invokes the ICMC as a GIIP, the selected financial assurance instrument will be capable of fully funding the decommissioning of all cyanide facilities in accordance with Standard of Practice 5.2 of the ICMC, assuming third-party costs.

2.6 Post-closure Phase

For the purposes of the TetraTech (2013), a nominal 2-year post-closure period was defined and is reflected in the initial closure cost estimate included in the first iteration of the Project *Mine Reclamation and Closure Plan* (see **Appendix 7B** of this updated ESIA). In actual practice, the predicted length of the post-closure monitoring period will be periodically examined, refined in annual reviews of the *Mine Reclamation and Closure Plan* (and ultimately, the *Detailed Mine Reclamation and Closure Plan*) as GGI gains experience with actual progressive closure actions and develops associated monitoring data that can be used to assess the effectiveness of selected reclamation, revegetation, and erosion prevention strategies over time. It is expected that these data will permit identification of the most successful reclamation, revegetation, and erosion prevention strategies that can be applied in final closure and that can be effectively monitored during post-closure. The final *Detailed Mine Reclamation and Closure Plan* submitted to the Guyana EPA may also include additional negotiated or supplemental post-closure monitoring actions or monitoring schedule extensions. These actions will be designed to facilitate final relinquishment or sale of the Project property, and may include:

- physical maintenance and inspection of earthworks, including embankments and any permanent spillways, drains, settling ponds, or diversion channels, in accordance with the current approved version of the *Tailings Area Management Plan* and *Erosion Prevention and Control Plan* (see **Appendix 7B**);
- continuation of surface- and groundwater monitoring programs, in accordance with the *Project Water Management Plan*;
- continued monitoring of revegetated areas to assess the success of vegetative rebound, in accordance with the *Erosion Prevention and Control Plan* (see **Appendix 7B**);
- continued monitoring for the colonization of reclaimed areas by native fauna, in accordance with the *Biodiversity Management Plan*; and

- continued monitoring for potential human influx to the Project area, in accordance with the *Influx Management Plan* (see **Appendix 7B**).

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Section 3:
Alternatives Assessment

Contents

3	Alternatives Assessment	3-2
3.1	Environmental Footprint Reduction	3-2
3.2	Description of Changes in Major Project Components	3-9
3.2.1	Open Pits	3-9
3.2.2	TMA	3-9
3.2.3	Mine Water Management, Diversion, and Fresh Water Ponds	3-10
3.2.4	Waste Rock, Saprolite, and Overburden Stockpiles	3-10
3.2.5	Man Camp	3-10
3.2.6	Airstrip	3-10
3.2.7	General Industrial Areas – Mineral Processing and Support Facilities	3-10
3.2.8	Cuyuni River Dike System	3-10
3.2.9	Internal Roads	3-10
3.2.10	Power Generation Alternatives, Energy Demand, and Fuelling Schemes	3-11
3.2.11	Access to Aurora Site	3-11
3.3	Summary of Advantages of the Selected Alternatives	3-11

List of Tables

Table 3.1	Comparison of Major Project Alternatives
Table 3.1-2:	Comparison of Modified and Natural Habitats and Streams to be Converted by Mine Footprint and Internal Roads for July 2010 and January 2013 Site Layouts

List of Figures

Figure 3.1-1:	Project Location, Original Conceptual Design (AMEC, 2010)
Figure 3.1-2:	Project Location, Final Design (TetraTech, 2013a)
Figure 3.1-3:	Project Location, Final Design [from (TetraTech, 2013a) with GIS Overlay]
Figure 3.1-4:	Comparison of Project Envelopes (includes 500-m buffer around mine footprint and internal roads)

3 Alternatives Assessment

The location of economically recoverable ore has defined the general physical boundaries of proposed open pit and underground mining operations for the Aurora Gold Project (Project) and limits siting options for the Project generally, as noted in Section 2.2.1 of this updated Environmental and Social Impact Assessment (ESIA). However, Guyana Goldfields, Inc. (GGI) explored several options for the location and design of the project's supporting infrastructure in a series of feasibility studies conducted from 2009 through 2013. This effort led to the definition of an initial Project design concept as documented in the July 2010 "Aurora Gold Project Overall Site Plan" (AMEC, 2010; Drawing No. A1-162022-0000-121-0100; **Figure 3.1-1**), which updated the site layout from AMEC's August 2009 "NI 43-101 Technical Report on Updated Preliminary Assessment, Aurora Gold Project, Guyana, South America" that was originally evaluated by the (ERM, 2010) ESIA. In late 2012 and early 2013, GGI conducted an additional study that generated a number of design alternatives that significantly reduced the overall physical and environmental footprint of the Project while improving Project economics. These changes also ensured that all Project components are located within the boundaries of GGI's current Mining License as well as minimizing the Project's footprint in accordance with the mitigation hierarchy (see **Figures 1.1-3 and 3.1-2**). These preferred alternatives form the basis of the final conceptual design for the Project, as documented in "NI 43-101 Technical Report, Updated Feasibility Study, Aurora Gold Project, Guyana, South America" (TetraTech, 2013a).

3.1 Environmental Footprint Reduction

A Geographic Information System (GIS) analysis was performed on the site layout plans from (AMEC, 2010) and (TetraTech, 2013a) in order to quantify the relative reduction in the Project's overall environmental footprint that is represented in the current (TetraTech, 2013a) design. Changes in footprint values are presented in **Table 3.1-1**; the source layout plans are included for information as **Figures 3.1-1 and 3.1-2**. **Figure 3.1-3** compares the footprints graphically by overlaying them on a single base map.

Table 3.1-1: Comparison of Project Environmental Footprint Changes in Final Conceptual Design

Major Features	(AMEC, 2010) Footprint	(TetraTech, 2013a) Footprint	Change (in ha/km and % reduction)
Open pits	133 ha	76 ha	-57 ha (-43%)
Tailings Management Area (TMA)	181 ha	222 ha	+41 ha (+23%)
Mine water management/ diversion/fresh water ponds	103 ha	101 ha	-2 ha (-2%)

Major Features	(AMEC, 2010) Footprint	(TetraTech, 2013a) Footprint	Change (in ha/km and % reduction)
Waste rock, saprolite, and overburden stockpiles	219 ha	136 ha	-83 ha (-38%)
Man-camp area	15 ha	10 ha	-5 ha (-33%)
Airstrip	23 ha	8.3 ha	-14.7% (-64%)
General industrial areas – mineral processing and support facilities	41 ha	20 ha	-21 ha (-53%)
Cuyuni River dike system	18 ha	14 ha	-4 ha (-22%)
Internal roads	36 km	16 km	-20 km (-56%)
Total Project Envelope	≈ 3898 ha	≈ 1911 ha	-1987 ha (-51.0%)

Comparing the “project envelopes” by extending a 500-m buffer around the total footprint, include roads, for each design demonstrates that the final design results in a reduction of 51.0% in the potential area to be disturbed by the Project, including indirect impacts within the 500-m buffer; see **Figure 3.1-4**.

In terms of modified and natural habitat (i.e., existing deforested vs. forested areas), the current site layout and internal roads will reduce the area of natural habitats affected by 25.1% and increase the use of existing modified habitats by 2.7% (see **Table-3.1-2**). Overall, the current site layout reduces the area of converted habitats by 23.4%. In terms of major aquatic habitats (i.e., streams, as there are no natural ponds, lagoons, permanent wetlands), there is no difference in the lengths of streams affected by the 2010 and 2013 site layouts for the mine footprint, but the current layout reduces the number of internal road crossings from 24 to 9, resulting in an overall reduction of 2.3% in the length of affected stream segments.

1

Feature		2010	2013	Change
Natural Habitat (ha)	Mine Footprint	685.1	535.6	-21.8%
	Internal Roads	65.1	26.3	-59.6%
	Total	750.2	561.9	-25.1%
Modified Habitat (ha)	Mine Footprint	48.1	48.6	+1.0%
	Internal Roads	0.5	1.3	+160%
	Total	48.6	49.9	+2.7%
All Habitats (ha)	Mine Footprint	733.2	584.2	-20.3%
	Internal Roads	65.6	27.6	-57.9%
	Total	798.8	611.8	-23.4%
Streams (km)	Mine Footprint	12.4	12.4	0%
	Internal Roads	0.48	0.18	-62.5%
	Total	12.9	12.6	-2.3%

¹ Assumptions included the table are as follows:

- All numbers are based on an ENVIRON analysis of Project layout maps using GIS and the high resolution imagery used at 1:10,000 scale in AMEC Drawing A1-162022-0000-121-0903-IMG (16 April 2009). Thus, actual use of modified habitat will be greater due to additional clearances conducted during the exploration phase of the Project.
- Average road width is 20 m (30 for haul roads and 15 for service roads), assuming a 1:2 ratio of haul to service roads. Roads within the footprint of major components are not counted in the road assessment.
- The only streams removed were directly within footprint of major components [e.g., Tailings Management Area (TMA), Mine Water Pond (MWP), Fresh Water Pond (FWP), open pits].

Figure 3.1-1: Project Location, Original Conceptual Design (AMEC, 2010)



Figure 3.1-2: Project Location, Final Design (TetraTech, 2013a)

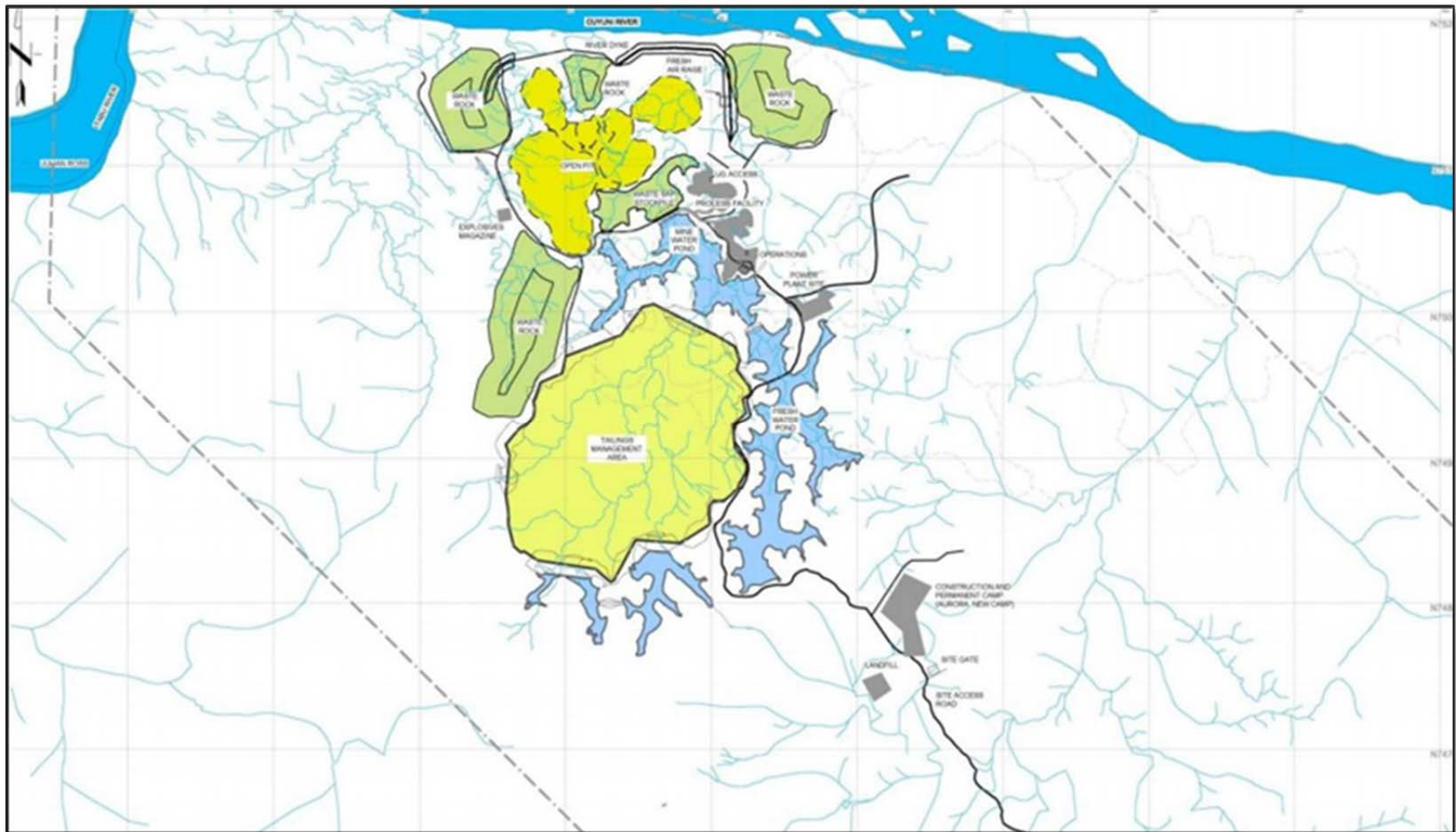


Figure 3.1-3: Project Location, Final Design [from (TetraTech, 2013a) with GIS Overlay]

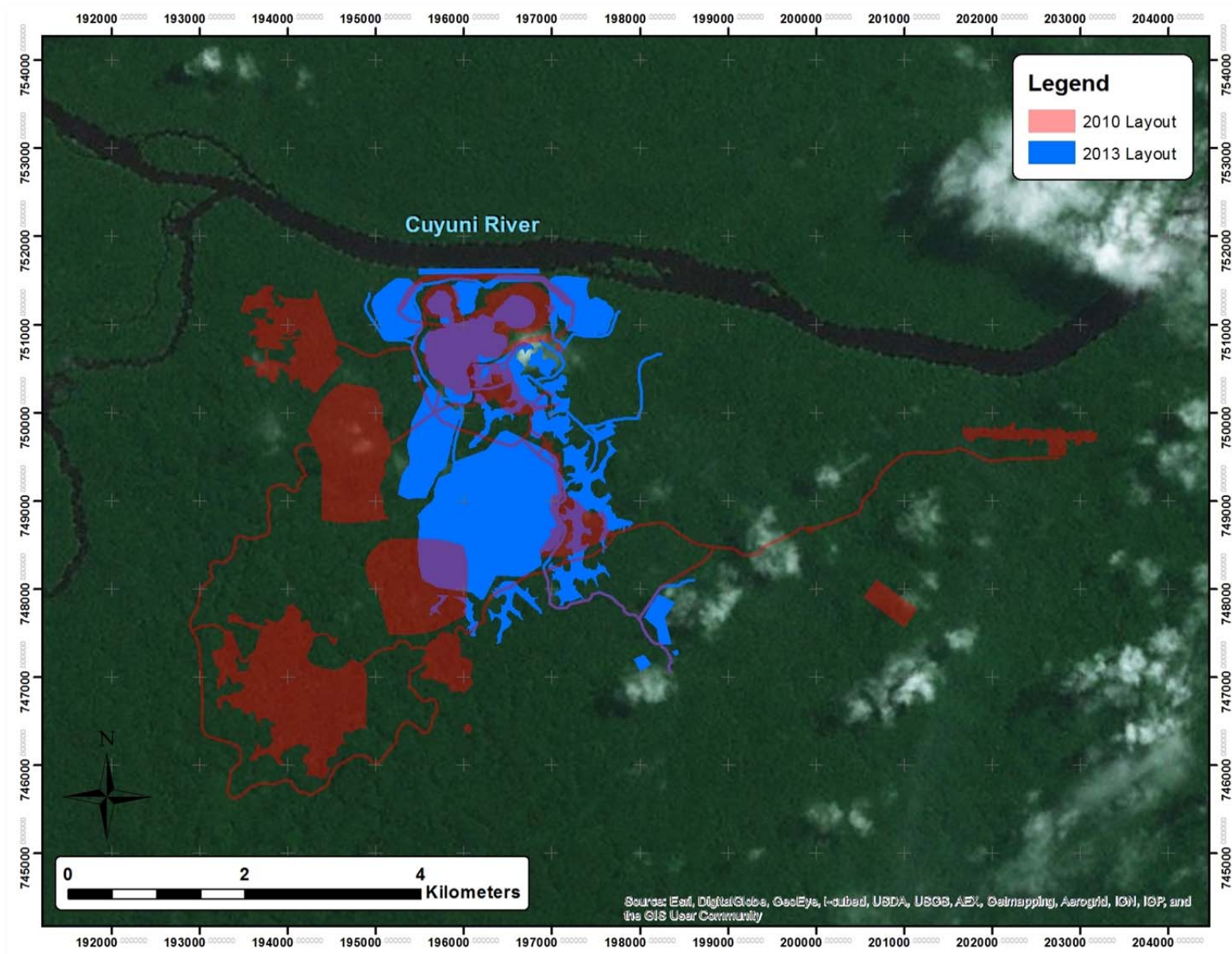
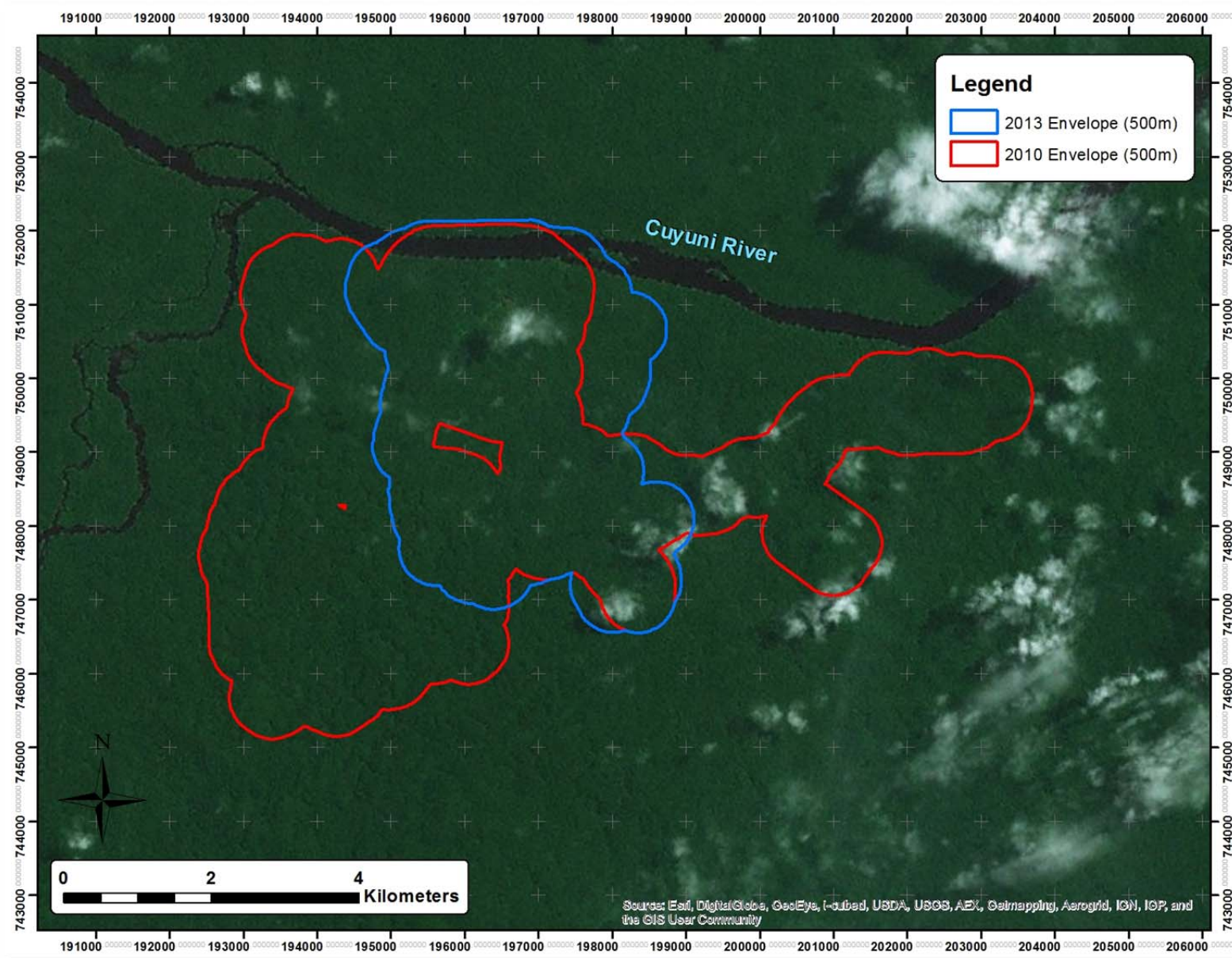


Figure 3.1-4: Comparison of Project Envelopes (includes 500-m buffer around mine footprint and internal roads)



3.2 Description of Changes in Major Project Components

Summaries of major changes to the project components between the updated preliminary assessment (AMEC, 2009)/July 2010 Site Plan (AMEC, 2010) and the updated feasibility study (TetraTech, 2013) are presented below. A summary of the environmental and social advantages of the current design is provided in Section 3.3.

3.2.1 Open Pits

While the location of the open pits is determined ultimately by the location of the mineral deposits, the mine design has optimized the geometry of the pits to reduce the footprint by 43% (57 ha) to a total of area of 76 ha.

3.2.2 TMA

As noted in **Table 3.1-1**, all major Project component footprints were reduced in the development of the final (TetraTech, 2013a) design except for the TMA. In the 2010 layout, the TMA was located approximately 3.5 km from the processing plant. Although the site offered an attractive topography for tailings management, the impacts of the forest clearance required for a 3.5 km connecting roadway and 3.5 km of tailings/reclaim water pipelines, the costs and environmental impacts associated with additional roadway construction, and the increased travel time required between major Project components outweighed any potential siting benefit.

It should be noted that a filtered (“dry stack”) tailings alternative was also evaluated as a potential alternative to the conventional detoxified tailings slurry disposal method that is common to both the (AMEC, 2010) and (TetraTech, 2013a) design. The evaluation was documented in a design memorandum (TetraTech, 2013b), and concluded that the alternative was not suitable for the site, for the following reasons:

- Filtered tailings lose a significant amount of undrained shear strength with excessive moisture content, which may result in significant handling difficulties when using conventional earthmoving equipment.
- The Project will exhibit a strongly positive water balance (see Section 2.4 and **Figure 2.4-4**); because precipitation will greatly exceed evaporation, the required desiccation of individual tailings lifts will be extremely difficult, if not impossible to achieve.
- Saprolite ores with high percentages of clay minerals are not conducive to effective filtration, which means that the Project would incur significantly high filtration costs and reduced filtration efficiencies.
- Tailings filtration in extremely wet environments with positive water balances could require increased water treatment needs if 100 percent of the filtrate cannot be re-cycled to process operations. Moreover, re-saturation of the tailings within the TMA during wet periods could lead to high rates of seepage and increase seepage collection and management costs.

In addition, paste tailings was also considered as alternative; however, this technology requires more power, cement, transportation, and other inputs which made this alternative neither economically feasible nor environmentally preferable.

3.2.3 Mine Water Management, Diversion, and Fresh Water Ponds

The location of these features has changed but the combined footprint is nearly identical between the 2010 and 2013 versions of the site layout, at 103 ha and 102 ha, respectively. Instead of one major pond occupying a small watershed to the west (upstream) of the open pit area which flows directly to the Cuyuni, the current design includes four reservoirs to the south of the pit area (i.e., TMA Diversion Ponds 1 and 2, the MWP, and the FWP).

3.2.4 Waste Rock, Saprolite, and Overburden Stockpiles

The combined footprint of these components has been significantly reduced during the mine planning process. The (AMEC, 2010) conceptual design included a total of 219 ha of stockpiles while the (TetraTech, 2013a) design had reduced this area by 83 ha to 136 ha, a reduction of 38%.

3.2.5 Man Camp

The initial site planned for the man camp was near the Cuyuni River west of Gold Creek; however, field surveys found this location to be swampy and potentially flood-prone. Subsequently, a higher well-drained site free of flood risk was sought. The final site is located at the top of a ridge to the southeast of the exploration phase camp along the permanent access road. This site will provide more healthful environment due to its drier, cooler, and breezier environment than lower-lying sites near the Cuyuni River that are just above river level.

3.2.6 Airstrip

Although new greenfield airstrip locations to the east and south of the mine site were considered as part of the (TetraTech, 2013a) effort, a final decision was made to rebuild the airstrip at its current location after the construction of the adjacent Cuyuni River dike system. While runway dimensions are identical in the AMEC and TetraTech designs (1200 m x 30 m), the TetraTech design completely eliminates the need for significant new forest clearances, earthworks, and connecting roadways, makes appropriate use of previously impacted land, and reduces the footprint by 64%.

3.2.7 General Industrial Areas – Mineral Processing and Support Facilities

The (TetraTech, 2013a) design reduced the footprint of the general industrial areas, including mineral processing and support facilities, by 53% or from 41 ha to 20 ha.

3.2.8 Cuyuni River Dike System

The (AMEC, 2010) design included a single dike measuring about 2.3 km in length with a crest elevation of 62.0 masl and 15-m crest width. The (TetraTech, 2013a) design considers final configuration of the pits and adjacent topography, and includes two separate structures measuring approximately 1.5 km each with crest elevations of 59.6 masl and 5-m crest widths.

3.2.9 Internal Roads

Due to the more compact layout of the mine site layout, the total length of internal roads was decreased from 36 km in the (SRK, 2012) design to 15-20 km in the (TetraTech, 2013a) design, reducing road-related impacts and fuel consumption.

3.2.10 Power Generation Alternatives, Energy Demand, and Fuelling Schemes

Preliminary designs for the Project estimated higher energy needs, and studies were performed for a series of hydroelectric power alternatives on the Cuyuni River and the Julian Ross itabu, as well as a combined hydropower and biomass alternative using trees removed from proposed reservoir area. However, these alternatives were rejected due to the complex impacts on the rivers that would be difficult to mitigate. The updated preliminary assessment (AMEC 2009) proposed a total of seven 5.82-MW heavy fuel oil (HFO) generators at peak (n+1 operational philosophy) with a total installed generating capacity of 40.74 MW based on the energy demands of the mine processing design. The updated feasibility study (TetraTech, 2013a) has significantly reduced the Project's energy demand and proposes the installation of up to eight 3.5-MW generators (n+1 operational philosophy) at peak with total installed generating capacity of only 28.0 MW, a reduction of 31.3%. As part of the development of the (TetraTech, 2013a) design, No. 4 fuel oil was also selected as a reasonable compromise between high-cost diesel fuel and HFO. Although HFO had been recommended by both (AMEC, 2009) and the previous feasibility study (SRK, 2012), this would have a less desirable air emissions profile resulting in greater emissions of greenhouse gases and other contaminants, and would have been considerably more difficult to transport and handle than the No. 4 blend.

3.2.11 Access to Aurora Site

The selection of the primary access route took into consideration the navigational difficulties presented by the various sets of rapids on the Cuyuni River and the existence of the Barama road. The transport of large machinery and mining equipment via the Cuyuni River is not possible due to multiple stretches of rapids, in particular at low flow, and transport via large helicopters would be impractical and cost-prohibitive. Construction of a new road south of the Cuyuni from Bartica would also be costly and would have had significant environmental impacts resulting from opening an area that is still free of roads. The location of Tapir Crossing was selected to take advantage of the existing Barama (M3) road and an existing spur logging trail north of the Cuyuni River. The selected alternatives maximize use of preexisting infrastructure, use previously impacted land, and thus avoid and minimize impacts relating to construction of new roads.

The use of the existing Barama road between Buckhall and the area north of Tapir Crossing area permitted the Project to avoid building a new road between the Essequibo River through less disturbed areas, and minimized that need for new road construction to a 33 km extension to reach Tapir Crossing and on to the Aurora site; see **Figures 1.1-2 and 1.1-3**.

3.3 Summary of Advantages of the Selected Alternatives

The iterative mine design process from the 2009 preliminary assessment through the 2013 updated feasibility study has resulted in the continual improvement and optimization of the mine layout, pit configuration, mineral processing, tailings management, and energy consumption. The overall project envelope was reduced by 51% from 39.0 km² to 19.1 km² and the direct footprint was reduced by 23.4%). The Project's mineral processing design was optimized such that the energy demand and required generation capacity was reduced from 40.7 MW to 28.0 MW (31.3%). By relocating the TMA, the Project will reduce the impacts of the forest clearance the connecting roadway and tailings/reclaim water pipelines, the costs and environmental

impacts associated with additional roadway construction, and the travel time required between major Project components. By utilizing the existing road network from Buckhall to the area just north of Tapir Crossing, the Project minimized new road construction needs to a 33 km extension, thereby avoiding the construction of new roads over large, previously unimpacted, and currently inaccessible areas.

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Section 4:
Environmental Baseline

Contents

	Page
4 Environmental Baseline	4-6
4.1 Area of Influence	4-9
4.2 History of Baseline Data Collection	4-12
4.2.1 Groundwater Sampling	4-12
4.2.2 Surface Water/Sediment Sampling	4-12
4.2.3 Biological Sampling	4-12
4.3 Climate	4-14
4.4 Air Quality	4-17
4.5 Hydrology	4-18
4.5.1 Surface Waters	4-18
4.5.2 Groundwater	4-21
4.5.3 2011 Investigation	4-24
4.6 Water Quality	4-27
4.7 Geology	4-43
4.7.1 Structural Geology	4-43
4.7.2 Geomorphology and Soils	4-44
4.7.3 Acid Rock Drainage and Metal Leaching Studies	4-47
4.8 Biodiversity	4-49
4.8.1 Scope of the Biodiversity Assessment	4-49
4.8.2 General Characterization of the Region	4-50
4.8.3 Biological Sampling of the Study Area	4-52
4.8.4 Regional and Biogeographic Settings	4-53
4.8.5 Biological Sampling Methodologies	4-58
4.8.6 Biological Sampling Results	4-65
4.8.7 Fish	4-70
4.8.8 Amphibians	4-73
4.8.9 Non-avian Reptiles	4-76
4.8.10 Birds	4-78
4.8.11 Mammals	4-90
4.8.12 Species Accumulation Curves	4-95
4.8.13 Invasive Alien Species	4-96
4.8.14 Critical Habitat Assessment	4-96
4.8.15 Legally Protected and Internationally Recognized Areas	4-116
4.8.16 Ecosystem Services	4-119

List of Figures

- Figure 4-1: Regional Setting of the Aurora Concession and the Cuyuni River Basin on the Map of the World Wildlife Fund (WWF) Ecoregions of the Guyana Region.
- Figure 4.1-1: Project Layout and Area of Influence (Aurora Site to Tapir Crossing)
- Figure 4.1-2: Area of Influence for the Environmental Baseline and Other Features
- Figure 4.5-1: Hydrologic Map of the Aurora Concession (yellow polygon) and Surrounding Area.
- Figure 4.5-2: Mean Daily Flows (m^3/s) for the Kamaria Falls and Akarabisi Stations for the Period 1947–1989 (MWH, 2008)
- Figure 4.5-3: Mean Daily Flows (m^3/s) at the Aurora Mine Location for the Period 1947–1989 (MWH, 2008)
- Figure 4.5-4: Mean Daily Flows (m^3/s) of the Cuyuni River at the Aurora Mine Location for the Period April 2004 – August 2006
- Figure 4.5-5: Groundwater Monitoring Well Locations (indicated by green triangles on map).
- Figure 4.6-1: 2006–2007 and 2009 Surface Water and Sediment Sampling Locations.
- Figure 4.7-1: Soil Types within the Aurora Mine Area of Influence
- Figure 8-1: Regional Setting of the Aurora Concession and the Cuyuni River Basin on the Map of the WWF Ecoregions of the Guyana Region.
- Figure 8.1.1: Direct Area of Influence for the Environmental Baseline and Other Features including the Locations of Biodiversity Transects and Sampling Points and Routes Traveled Repeatedly during Field Work
- Figure 4.8-1: Guiana Shield Initiative (GSI) Priority Areas in the Cuyuni and Mazaruni River Basins.
- Figure 4.8-2: 2011 Wet and Dry Season Fish Sampling Locations in the Aurora Concession
- Figure 4.8-3: Number of New Species of Flora and Birds versus Sampling Years
- Figure 4.8-4: Number of New Species of Mammal, Amphibian, Reptile, and Fish versus Years of Survey
- Figure 4.8-5: Distribution of Localities for Missouri Botanical Garden Specimens of *Viola surinamensis* for which Coordinates are Available.
- Figure 4.8-6: Estimated Range of *Stefania evansi* (yellow polygon) and Aurora Concession (red polygon).
- Figure 4.8-7: Alliance for Zero Extinction Sites in the Guiana Shield Region.
- Figure 4.8-8: Alliance for Zero Extinction Sites in Northern South America, Mesoamerica, and the Caribbean.

Figure 4.8-9: Protected Areas in Guyana and Adjacent Areas. Source: Data from 2009 World Database of Protected Areas

List of Tables

Table 4.2-1:	History of biodiversity field surveys in the vicinity of the Aurora Project site, 2006 to 2012
Table 4.3-1:	Summary of average monthly climate data from the Aurora Station from June 2006 to September 2011
Table 4.3-2:	Overall 2006-2011 summary of available climate data from the Aurora Station
Table 4.5-1:	Depth to groundwater in meters
Table 4.5-2:	Summary of hydraulic conductivities in centimeters per second
Table 4.5-3:	Locations, depths, and identification of well nests at Aurora and formation in which each is screened
Table 4.5-4:	Groundwater elevations and hydraulic conductivity in centimeters per second (cm/s) for each screened geologic formation at Aurora
Table 4.6-1:	Surface water analytical results in milligrams per liter (mg/L), February 10, 2006
Table 4.6-2:	Surface water analytical results in milligrams per liter (mg/L), July 6, 2006
Table 4.6-3:	Surface water analytical results in milligrams per liter (mg/L), October 12, 2006
Table 4.6-4:	Surface water analytical results in milligrams per liter (mg/L), March 4, 2007
Table 4.6-5:	2009 Surface water analytical results
Table 4.6-6:	2009 sediment analytical results
Table 4.6-7:	Results of analytical tests on surface water samples at Aurora (2011).
Table 4.6-8:	Results of analytical tests on sediment samples at Aurora (2011).
Table 4.6-9:	Groundwater analytical results, February 10, 2006
Table 4.6-10:	Groundwater analytical results, July 6, 2006
Table 4.6-11:	Groundwater analytical results, October 12, 2006
Table 4.6-12:	Groundwater analytical results, March 4, 2007
Table 4.6-13:	2009 groundwater analytical results
Table 4.6-14:	Results of analytical tests on 2011 groundwater samples at Aurora
Table 4.7-1:	Major characteristics of soil types found on the project site
Table 4.8-1:	Description of Guiana Shield Initiative (GSI) priority areas in the Cuyuni and Mazaruni River basins
Table 4.8-2:	Primary transect locations and descriptions for 2011 wet season terrestrial surveys at the Aurora concession

Table 4.8-3:	Secondary transects established perpendicular to primary transects during 2011 wet season surveys at the Aurora concession.
Table 4.8-4:	2011 wet and dry season fish sampling dates, locations, sampling hours, and tackle
Table 4.8-5:	Dominant and frequently occurring plant species at Aurora during the 2011 dry season.
Table 4.8-6:	Fish sampled at Aurora during 2011 wet and dry season surveys
Table 4.8-7:	Summary of amphibians identified during 2011 wet and dry season surveys at Aurora
Table 4.8-8:	Migratory bird species reported from all surveys
Table 4.8-9:	Guianan Shield endemic bird species reported from the Aurora concession during all field surveys.
Table 4.8-10:	Bird species observed at Aurora during 2011 wet and dry season surveys
Table 4.8-11:	Non-chiropteran mammals observed during the 2011 surveys
Table 4.8-12:	Bats captured during the 2011 wet and dry seasons at Aurora
Table 4.8-13:	Freshwater fish species considered endemic to Guyana
Table 4.8-14:	Amphibians endemic to lowland (<500 masl) Guyana, the Guianan Moist Forests Ecoregion (GMFE), or with restricted ranges (<50,000 km ²) that include the Lower Cuyuni-Mazaruni Basins (adapted from Frost, 2009; Señaris & MacCulloch, 2005; and http://Intreasures.com/guyanaa.html)
Table 4.8-15:	Non-avian reptiles endemic to the Guiana Shield Region and known to be present in Guyana (adapted and updated from Avila-Pires, 2005)
Table 4.8-16:	Guiana Shield endemic birds (after Milensky et al., 2005)
Table 4.8-17:	Guiana Shield endemic mammals, after Lim et al. (2005)

List of Appendices

Appendix 4A:	Bio-Assessment of the Cuyuni River near Aurora, Guyana, Environmental and Economic Implications, October 2009
Appendix 4B:	CBSD Review of Aurora Project Biodiversity Baseline Studies

List of Images

Image 4-1:	Cuyuni River and a tributary (lower center part of photograph) showing a small-scale mining operation with visibly high suspended sediment loads in the tributary and the margins of the river, April 2009. Source: Langstroth, 2009
Image 4.8-1:	Cuyuni River and a tributary (lower center part of photograph) showing a small-scale mining operation with visibly high suspended sediment loads in the tributary and the margins of the river, April 2009. Source: Langstroth, 2009

- Image 4.8-1: Barama Road and associated small-scale mining activity to north of the Cuyuni River, March 2009. Source: Langstroth, 2009
- Image 4.8-2: Secondary vegetation in Golden Mile area of the Aurora concession, March 2009. Source: Langstroth, 2009
- Image 4.8-3: Cuyuni floodplain forest with *Mora excelsa* trees, Aurora concession, March 2009. Source: Langstroth, 2009
- Image 4.8-4: Ridgetop forest in Aurora concession, March 2009. Source: Langstroth, 2009
- Image 4.8-5: *Hoplias malabaricus* (haimara) caught by small-scale miners at camp near Alligator Creek in a concession not owned by GGI outside of the Aurora concession, April 2009. Source: Langstroth, 2009
- Image 4.8-6: Fine sediment along lower reach of Alligator Creek, affected by upstream ASM activity, April 2009. Source: Langstroth, 2009
- Image 4.8-7: *Allobates femoralis*, an abundant forest floor frog in the Aurora concession, April 2009. Source: Langstroth, 2009
- Image 4.8-8: *Anolis planiceps*, a common forest floor lizard in the Aurora concession, April 2009. Source: Langstroth, 2009
- Image 4.8-9: Guiana red howler monkeys (*Alouatta macconnelli*) along Cuyuni River across from Aurora concession, May 2009. Source: Langstroth, 2009
- Image 4.8-10: *Rhaebo nasicus* toad at Aurora concession, May 2009

4 Environmental Baseline

This environmental baseline discussion characterizes the physical and biological environments in the Area of Influence (AOI) of the GGI Aurora Gold Project (Project). It builds on the information presented in the initial iteration of the *Final [sic] Environmental and Social Impact Assessment (ESIA) of the Aurora Mine Project in Guyana* (ERM, 2010) and introduces new information gained in public consultations, in discussions with leaders of independent field studies, and other new field studies conducted for Guyana Goldfields, Inc.(GGI) by ENVIRON International Corporation (ENVIRON), Ground Structures Engineering & Construction, Ltd. (GSEC), Klohn Crippen Berger, and other consultants in 2011 and 2012. As recommended by the International Finance Corporation (IFC), it provides the abiotic and biodiversity information required to identify priority biodiversity features of the Project's AOI for a critical habitat assessment and for future monitoring of mitigation measures. It also considers the independent review comments provided by the University of Guyana Centre for the Study of Biological Diversity (CSBD); see (CSBD. 2013).

Biodiversity is evaluated in a regional context that includes the AOI and the surrounding region, the latter being defined as the Moist Forest Zone of the coastal lowlands (Schipper et al., 2012), or Atlantic Coastal Shelf (Hammond, 2005). As suggested by **Figure 4-1**, below 500 meters above sea level (masl), Guianan Moist Forest fauna are largely shared with other humid lowland ecoregions of the Amazon Basin.¹

The forest-river systems of the Cuyuni basin are integrated through surface and groundwater hydrological processes, and the forests are important for the maintenance of hydrology and water quality. The natural surface waters of the region are generally considered “blackwaters,” with low pH, high contents of tannins and humic organic acids from the breakdown of leaf litter, and low suspended solids. But in the Cuyuni basin, the natural condition has been altered by human impacts. Artisanal and small-scale mining (ASM) has been identified as the leading cause of deforestation in Guyana, responsible for 94% of deforestation (Guyana Forestry Commission, 2012). During the 2010–2011 period, deforestation totaled 9,796 hectares per year (ha/yr), and the majority of this (96%) took place in state forests, primarily along the rivers, the primary means of egress, and along existing roads.

The biodiversity and environmental quality of the greater Project area has been significantly and adversely affected by mining and to some extent logging. Despite the relatively remote location, the Project area shows signs of environmental degradation and depletion of fauna.

The Cuyuni River Basin and much of Region 7 and adjacent areas of Guyana have been historically affected by mining activities since at least the 1800s (Perkins, 1893). Gold and other mineral deposits of market value occur in alluvial sediments and in ore form. ASM activities have been and continue to be primarily surface alluvial mining along tributary creeks to the Cuyuni, but dredging of the river bed sediments is another popular method.

¹ This lowland ecoregion of Guyana should not be confused with the Guiana Highlands that includes the tepui formations which are characterized by relatively high levels of endemism or the Rupununi savanna in southern Guyana.

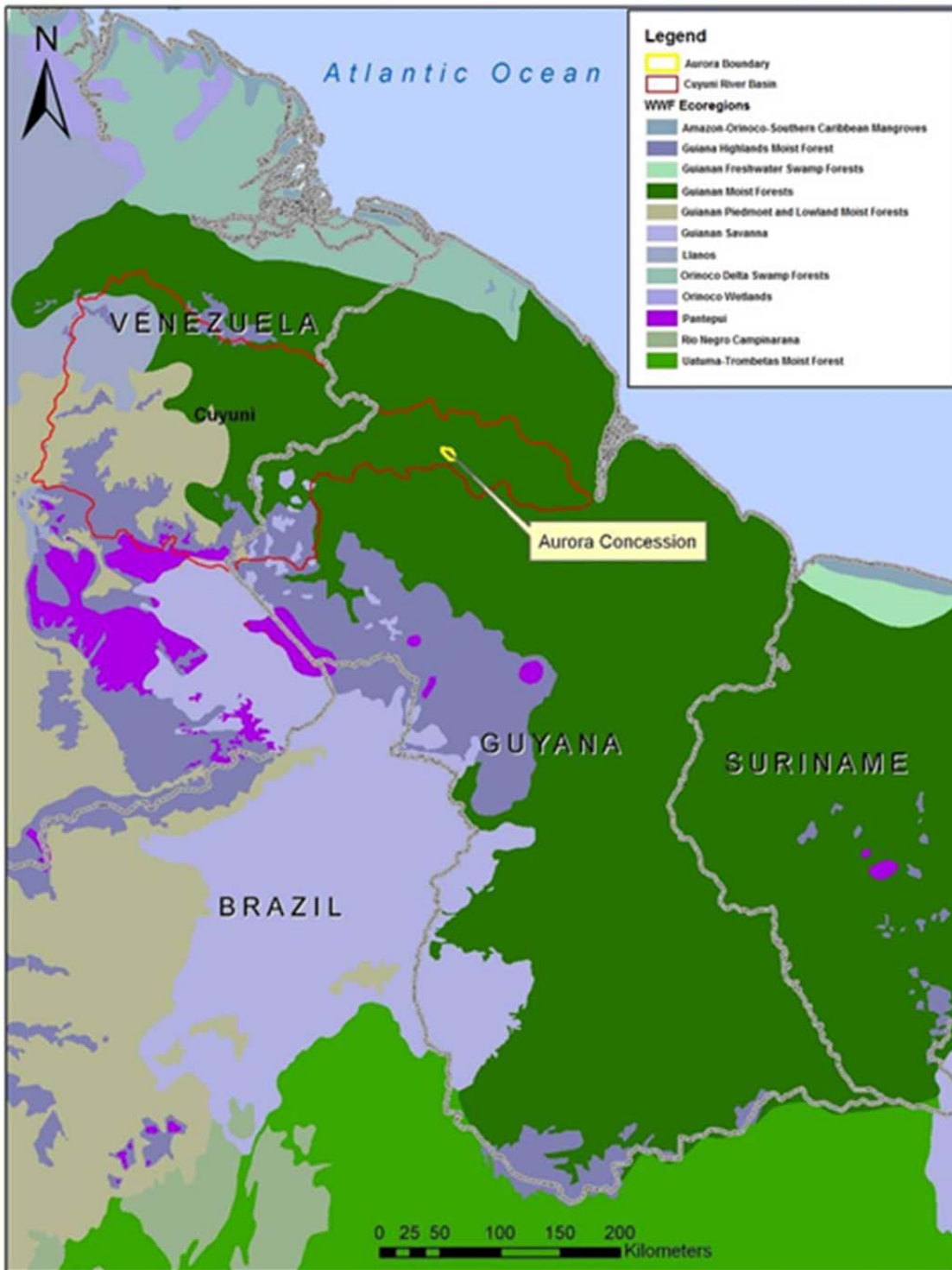


Figure 4-1: Regional Setting of the Aurora Concession and the Cuyuni River Basin on the Map of the World Wildlife Fund (WWF) Ecoregions of the Guyana Region. Source: Schipper et al., 2012.

This type of mining has led to a vast increase in turbidity and sedimentation in the river. The use of mercury in the amalgamation process and its release to the environment is another major environmental concern in Region 7. Studies of sediments in the Mazuruni and Essequibo suggest that that much of the mercury found in the alluvial deposits is related to anthropogenic sources and has increased in recent years (Miller et al., 2003).

There has been some research on mining impacts in the Venezuelan portion of the Cuyuni basin (Nico & Taphorn, 1994; García-Sánchez et al., 2008), as well as general studies in Guyana by World Wildlife Fund (WWF) (Lowe, 2008). These studies indicate that fish abundance and diversity of the upper Cuyuni River basin in Venezuela has been adversely affected by historical artisanal mining (some of which is considered to be large scale) due largely to impacts from accelerated sedimentation and increased turbidity. The Cuyuni River has experienced degradation of water quality since the 1980s from the discharge of sediment- and contaminant-laden waters from ASM into its tributaries (**Image 4-1**). The river has become



Image 4-1: Cuyuni River and a tributary (lower center part of photograph) showing a small-scale mining operation with visibly high suspended sediment loads in the tributary and the margins of the river, April 2009. Source: Langstroth, 2009

increasingly turbid and mercury has accumulated in the aquatic ecosystem. Depletion of fauna in and near the Cuyuni River has been well documented in studies such as Duplaix (2009) (see **Appendix 4A**). Significant loss of diversity and depletion of abundance in fish species in the Cuyuni River and its tributaries due to the turbidity and other water quality issues resulting from

current and historical ASM has also been independently observed both upstream and downstream from the Project concession area.²

4.1 Area of Influence

The Project is presently conceived as an open-pit and underground gold mining operation, conventional crushing and milling process, and a carbon-in-leach (CIL) cyanidation process for mineral extraction. Open-pit operations are expected to be complete in approximately 5-6 years, and underground operations will continue for at least an additional 15 years. After the completion of the open-pit phase, the footprint of the mining operation will be generally stable over the remainder of mine life.

The current conceptual configuration of the Project site at closure is presented in **Figure 4.1-1**, and includes mined-out open pit areas, waste rock and topsoil stockpiles, ore crushing and milling facilities, and the mineral processing plant. Detoxified tailings will be deposited via pipeline to a Tailings Management Area (TMA) to the immediate southwest of the process facility and a Mine Water Pond (MWP).

The mine site will be supported by mechanical shops, warehouses, electrical generators, fuel storage tanks, a 400–500 (at maximum staffing) man-camp, potable water and sanitary waste disposal systems, a hazardous waste accumulation area, secure explosives storage silos and magazines, administrative offices, an airstrip, a solid waste landfill, and related infrastructure. The Project also includes the Buckhall wharf and logistics center on the Essequibo River, a ferry landing (Tapir Crossing) on the Cuyuni River, and the road from Buckhall to Aurora, the greater portion of which is shared with Barama Company Limited, the operator of a large timber concession north of the Cuyuni.

The overall AOI for the environmental baseline is presented in **Figures 4.1-1** and **4.1-2** and incorporates a 500-meter (m) buffer from the maximum perimeter of the Aurora site mining operation and either side of the access road between the Aurora site and Buckhall.

² Noted in (Sidlauskas, 2011), "Preliminary Trip Report: Ichthyological Survey of the Cuyuni River in Guyana"; unpublished report personally communicated from Dr. Brian Sidlauskas (Oregon State University) to Dr. Robert Langstroh (ENVIRON), March 2013.

Figure 4.1-1: Project Layout and Area of Influence (Aurora Site to Tapir Crossing)

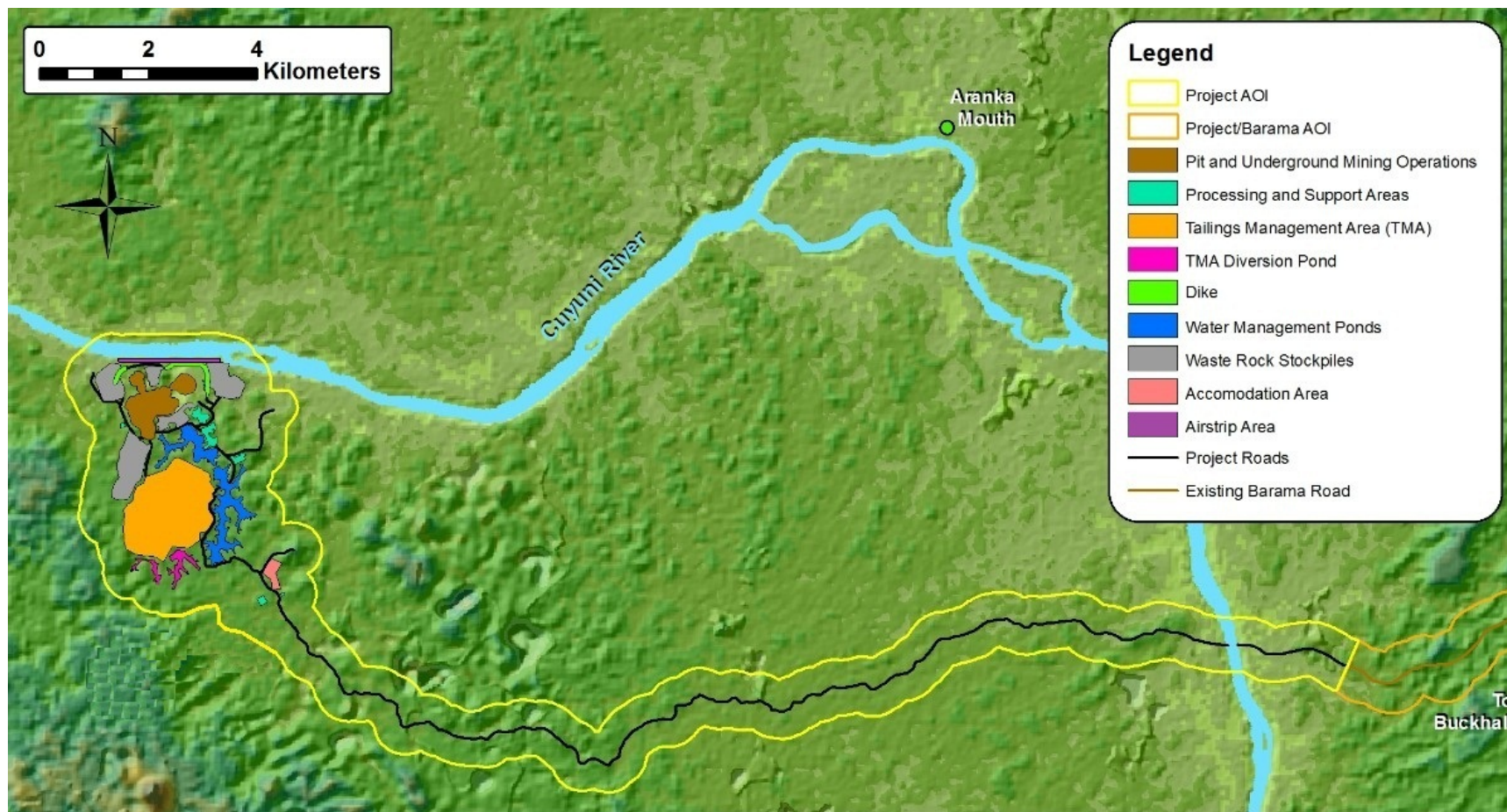
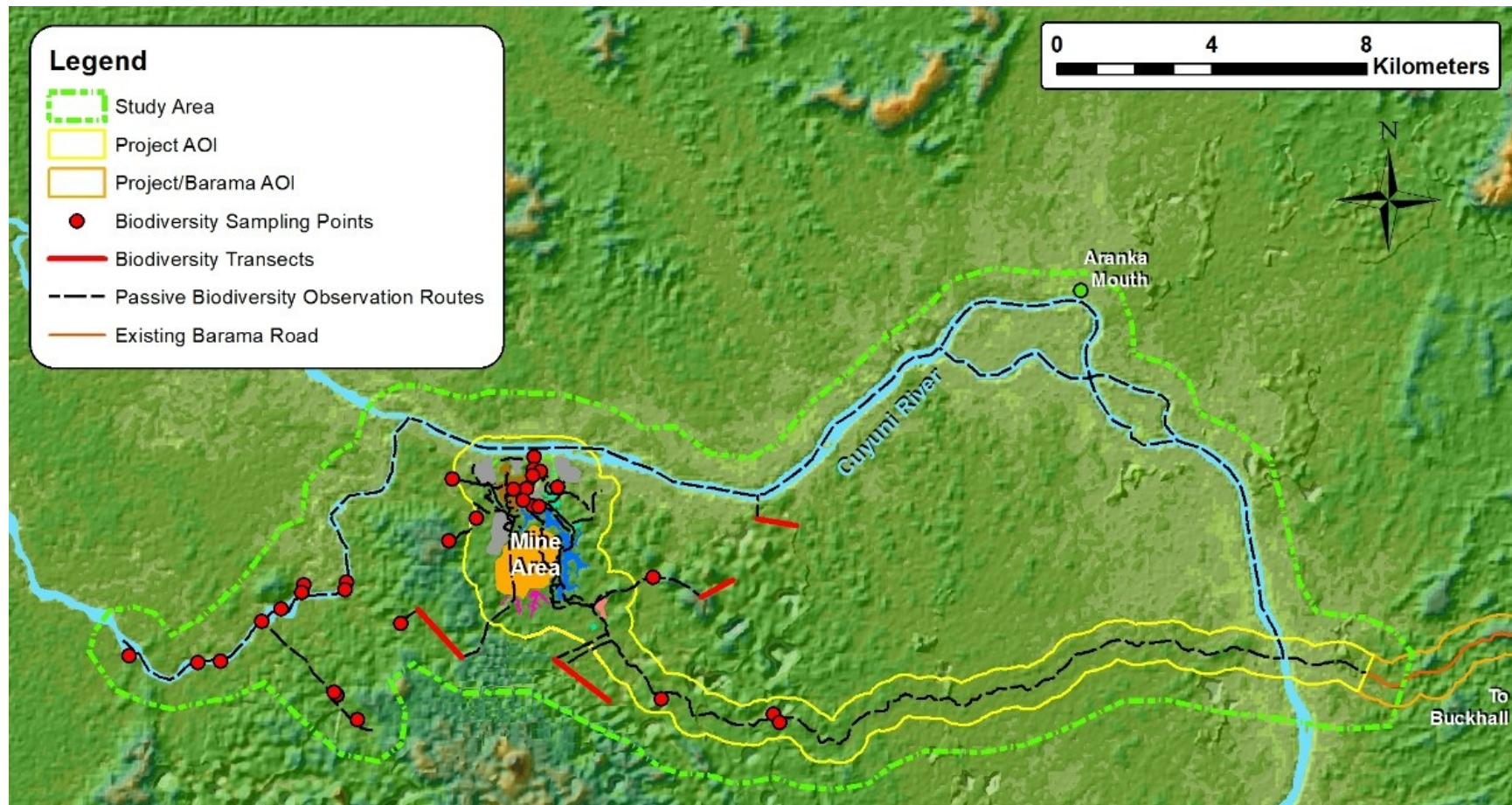


Figure 4.1-2: Area of Influence for the Environmental Baseline and Other Features (includes the locations of biodiversity transects, sampling points, and routes traveled during field work)



4.2 History of Baseline Data Collection

The Project has a long history of field data collection for the purpose of characterizing the existing environmental conditions at the Aurora site and vicinity. Formal studies began in 2006 and have continued through 2012.

4.2.1 Groundwater Sampling

In 2009, GSEC performed representative groundwater sampling from monitoring wells located in the vicinity of the proposed TMA and MWP, as well as the area proposed for open-pit mining operations. The purpose of the groundwater sampling was to establish baseline groundwater conditions prior to development of the property for large-scale mining operations. Groundwater samples were collected from each monitoring well in accordance with United States Environmental Protection Agency (USEPA) guidelines. Groundwater samples were analyzed for metals and other constituents/parameters specified by IFC guidelines/protocols for gold mining operations (i.e., the *Environmental, Health, and Safety Guidelines for Mining* [IFC, 2007] and the International Cyanide Management Code [ICMC] as referenced therein). Laboratory analysis of groundwater samples was performed by Exova Accutest of Ottawa, Canada.

In 2011, another groundwater hydrology investigation was undertaken in response to concerns raised by the IFC with regards to an earlier pump test completed in 2010. The IFC requested that additional studies be performed to delineate the horizontal and vertical groundwater flow gradients at both concessions as well as to provide spatial estimates of hydraulic conductivity and baseline groundwater quality. The 2011 investigation also included surface water and sediment sampling.

4.2.2 Surface Water/Sediment Sampling

In 2009, GSEC collected surface water and sediment samples along the Cuyuni River from locations upstream, adjacent to, and downstream of the Aurora Mine site. The purpose of the surface water/sediment sampling was to establish baseline conditions along the Cuyuni River prior to development of the property for large-scale mining operations. Surface water and sediment samples were analyzed for metals and other constituents/parameters specified by IFC guidelines/protocols for gold mining operations (i.e., IFC, 2007 and the ICMC). Surface water and sediment samples were also analyzed by Exova Accutest. Additional surface water and sediment sampling was also completed during the 2011 wet season surveys.

4.2.3 Biological Sampling

Biological sampling or biodiversity surveys began in 2006 and are summarized in **Table 4.2-1** below. The initial biological surveys of the Aurora concession were performed in 2006 and 2007 by Guyanese biologists and the WWF. To upgrade the existing baseline information, a biodiversity assessment was conducted for the Project AOI in 2009 by the consulting firm Environmental Resource Management, Inc. (ERM) with a focus on determination of presence or absence of critical habitat as defined by IFC Performance Standard (PS) 6 (IFC, 2012a). The assessment used various data sources and methodologies including satellite imagery, literature surveys, field sampling and capture, direct observation, and where appropriate interviews. Data collection for the physical environment focused on surface water hydrology, geology, topography, soil type, climate and meteorology, ambient air quality, noise and water quality, as discussed below. The biodiversity data collection focused on flora and fauna, endemic and

threatened species, identification of potential sensitive habitats including wetlands, species of socioeconomic or cultural importance, migratory and congregational species, and protected areas in the region.

The 2009 field inventory of biological resources for the Aurora mine site and vicinity was performed from April 28 through May 5, 2009. During this period, biological features at the mine site and its environs were characterized. Both diurnal and nocturnal surveys were conducted. The vegetation of the Golden Square Mile, the TMA and MWP areas (as identified at the time of the survey), and the Julian Ross Itabu areas were characterized by cataloging the dominant tree and shrub species. This included sample collection of certain plants, identification and recording. Fish were sampled by netting and hook and line. Amphibians and reptiles were sampled by visual encounter surveys (VES) and auditory surveys. Birds were sampled by point counts and mist netting. Mammals were documented by direct and indirect observation (e.g., tracks, scat, fur) supplemented by interviews with Guyanese experts on the biodiversity of the area.

Table 4.2-1: History of biodiversity field surveys in the vicinity of the Aurora Project site, 2006 to 2012			
Description	Dates	Calendar Days	Season
WWF Initial Survey	January 17 to February 4, 2006	19	Wet
GSE Initial Survey	July 1 to July 7, 2006	7	Wet
GSE Initial Survey	October 06 to October 13, 2006	8	Dry
GSE Initial Survey	February 22 to March 05, 2007	12	Dry
ERM ESIA Survey	April 28 to May 5, 2009	8	Dry
Nicole Duplaix Giant Otter Survey	October 14 to October 21, 2009	9	Dry
Julian Ross Itabu Surveys	May 2011	4	Dry
General Baseline Surveys	July 28 to August 26, 2011	16	Wet
Flora, Bats, Birds, and Fish Surveys	October 22 to November 03, 2011	13	Dry
Mammal and Herpetofauna Surveys	November 5 to November 14, 2011	10	Dry
Aurora Early Works Footprint Surveys	June 2 to June 6, 2012	5	Wet
TOTAL		111	

A specialized survey for giant otters was completed along the Cuyuni River, including the Julian Ross Itabu Branch, and various tributaries from October 13 through 22, 2009, by international giant otter specialist Dr. Nicole Duplaix.³ No otters or recent evidence for their presence was observed. Dr. Duplaix concluded that the habitat was not suitable given the high level of turbidity in the rivers (largely from ASM activity upstream of the study area), and that the two lone individual specimens sighted in multiple years of baseline field work were likely migrants passing through the area and not resident.

In 2011, two additional biological assessments at the Aurora concession were conducted by local ecological specialists under the supervision of ENVIRON. A wet season assessment was conducted between July and September 2011 and the dry season from October to November 2011. The wet and dry season assessments were designed to 1) validate the previous findings of biological surveys conducted in 2009 at Aurora and 2) evaluate the presence of critical habitat under the criteria set forth by the latest version of IFC PS 6 (IFC, 2012b). This standard defines critical habitats as areas having high biodiversity value and may include the following:

- habitats of significant importance to Critically Endangered and/or Endangered species;
- habitats of significant importance to endemic and/or restricted-range species;
- habitats of supporting globally significant concentrations of migratory species and/or congregatory species;
- highly threatened or unique ecosystems; and/or
- areas associated with key evolutionary processes.

In addition, an independent ichthyological survey of the Cuyuni River upstream and downstream of the Aurora concession was also conducted by a scientific team from the University of Oregon in early 2011 (Sidlauskas, 2011). Preliminary conclusions from the study suggest that high sediment loads primarily associated with current and historical ASM activities have contributed to very significant loss of species diversity and depleted fish abundance that is "...highly unusual for a South America river..." and represents "...a substantial alteration of the river's natural state."

4.3 Climate

Guyana is located in the Equatorial Trough Zone (ETZ) and its weather and climate are influenced primarily by the seasonal shifts of the ETZ and its associated rain bands within an area referred to as the Inter Tropical Convergence Zone (ITCZ). These factors result in seasonality of rainfall with a bimodal distribution.

The closest historical weather station was located at Kamaria Falls on the Cuyuni River, which is approximately 125 kilometers (km) downstream of the Aurora concession. Daily rainfall and

³ See "Bio-assessment of the Cuyuni River near Aurora: Environmental and Economic Implications" (Duplaix, 2009); full text is included as **Appendix 4A**.

stream flow data from this station for the period 1971–1980 were reviewed to develop estimates of weather parameters prior to the commencement of detailed field monitoring in the area of the Project. Data on evaporation and temperature for this station are not available. The maximum monthly rainfall recorded at Kamaria Falls was approximately 492 millimeters (mm), while the minimum monthly rainfall recorded over the same period was 10 mm. Formation of El Niño and La Niña weather patterns can disturb the regular location of the ITCZ and thus result in higher or lower than normal rainfall at specific locations. The El Niño/La Niña cycle is primarily responsible for interannual variation in rainfall. The maximum and minimum annual rainfall at Kamaria Falls for the period 1971–1980 was 2,710 mm and 1,956 mm, respectively.

An automated weather station was installed at the Project site in June 2006 to collect baseline data, providing an automated record of minimum and maximum temperatures, total rainfall, rainfall rate, maximum and average wind speeds and directions, barometric pressure, humidity, solar radiation, and several other parameters. Data have been collected at one-half hour intervals since installation in 2006, although a number of data gaps exist that are attributable to equipment malfunctions or other operational issues. **Table 4.3-1** presents a monthly summary of selected key parameters through September of 2011.

Table 4.3-1. Summary of average monthly climate data from the Aurora Station from June 2006 to September 2011 (Note: All parameters are monthly averages except precipitation, which shows the total for the given month. Months marked with an asterisk (*) have less than 15 days of data and are therefore not calculated.)

Year	Month	Temperature (C)	Humidity (%)	Wind Speed (m/sec)	Pressure (mm Hg)	Precipitation Total (mm)
2006	June	*	*	*	*	*
	July	25.4	90.0	2.8	760	356
	August	26.0	87.3	2.2	759	152
	September	26.2	86.0	2.5	759	80
	October	26.0	89.9	2.3	757	187
	November	25.6	90.5	2.2	757	113
	December	*	*	*	*	*
2007	January	24.9	91.3	2.3	759	74
	February	24.8	84.5	3.1	760	39
	March	*	*	*	*	*
	April	*	*	*	*	*
	May	*	*	*	*	*
	June	*	*	*	*	*
	July	*	*	*	*	*
	August	*	*	*	*	*
	September	*	*	*	*	*
	October	*	*	*	*	*
	November	25.5	89.6	1.4	757	188
	December	*	*	*	*	*
2008	January	24.1	91.0	1.5	758	188
	February	24.0	90.3	1.8	759	169

Table 4.3-1. Summary of average monthly climate data from the Aurora Station from June 2006 to September 2011 (Note: All parameters are monthly averages except precipitation, which shows the total for the given month. Months marked with an asterisk (*) have less than 15 days of data and are therefore not calculated.)

Year	Month	Temperature (C)	Humidity (%)	Wind Speed (m/sec)	Pressure (mm Hg)	Precipitation Total (mm)
2009	March	*	*	*	*	*
	April	*	*	*	*	*
	May	25.1	91.2	1.3	759	255
	June	25.3	90.5	1.2	759	119
	July	*	*	*	*	*
	August	26.3	86.9	1.5	758	64
	September	26.6	86.7	1.4	758	91
	October	*	*	*	*	*
	November	*	*	*	*	*
	December	*	*	*	*	*
	January	24.4	93.6	1.1	760	241
	February	24.5	89.9	1.5	759	171
	March	25.1	90.6	1.3	759	102
	April	25.3	90.3	1.3	760	242
	May	25.9	87.6	1.7	760	90
	June	25.6	89.8	1.6	760	144
	July	*	*	*	*	*
	August	*	*	*	*	*
	September	*	*	*	*	*
	October	26.1	87.7	2.1	758	262
	November	26.2	87.8	2.0	758	75
	December	24.9	90.0	2.0	759	138
2010	January	24.6	86.5	2.1	760	33
	February	26.1	82.2	2.9	759	25
	March	26.7	82.5	2.8	759	72
	April	26.9	85.3	2.1	759	171
	May	26.1	90.3	2.0	759	268
	June	26.1	88.5	2.1	760	7
	July	25.8	89.4	1.6	760	106
	August	26.1	88.0	1.5	759	90
	September	26.7	84.9	2.2	758	182
	October	26.6	85.8	2.2	759	39
	November	*	*	*	*	*
	December	25.3	89.4	1.7	757	68
2011	January	24.6	88.5	2.2	758	84
	February	24.6	89.5	2.3	759	163
	March	24.3	90.7	1.8	759	168
	April	26.5	82.0	2.1	758	8

Table 4.3-1. Summary of average monthly climate data from the Aurora Station from June 2006 to September 2011 (Note: All parameters are monthly averages except precipitation, which shows the total for the given month. Months marked with an asterisk (*) have less than 15 days of data and are therefore not calculated.)

Year	Month	Temperature (C)	Humidity (%)	Wind Speed (m/sec)	Pressure (mm Hg)	Precipitation Total (mm)
	May	26.1	89.1	2.0	759	75
	June	25.7	89.6	2.1	759	121
	July	25.6	88.6	2.3	759	122
	August	26.3	85.4	2.2	759	175
	September	26.7	84.4	2.2	759	8

Table 4.3-2 summarizes the averages of these same key parameters over the same data range, as well as high and low parameter values.

Table 4.3-2. Overall 2006-2011 summary of available climate data from the Aurora Station (Note: precipitation data represent a yearly average where such data are available. All other parameters are averages across the entire time range. The high and low yearly averages were calculated by extrapolating the average of the available data for that year to the missing days for year. The average for the entire data range was calculated by extrapolating the average of the available data over the entire range to the missing days.)

	Temperature (C)	Humidity (%)	Wind Speed (m/sec)	Pressure (mm Hg)	Precipitation (mm)
Average	25.6	88.2	2.0	760	1777
High	35.1	100.0	27.4	765	2311 (in 2006)
Low	18.2	39.0	0	752	1251 (in 2010)

4.4 Air Quality

There is no significant industrial development in the Project area. Local air emissions are directly related to the rotting of trees and other vegetative matter. Some aerial emissions are also related to the operation of dredges in the vicinity of the mining concession and from ASM exploration equipment (e.g., dozers and backhoes).

Airborne discharges and particulate matter have not been monitored in the area. However, IFC environmental health and safety (EHS) guidelines for sulfur emissions specify two levels of allowable emissions. If the region is unpolluted, the maximum allowable emissions should not exceed 500 tonnes per day (tpd). If the region is polluted, the maximum allowable emissions should not exceed 100 tpd. The level of industrial development is so minimal that neither criterion is expected to be exceeded.

As of the date of this report, there were no informal or formal settlements with significant fixed or mobile sources of atmospheric emissions in the area surrounding the Aurora concession. The existing prospecting activities in the concession typically involve the use of all-terrain vehicles (ATVs), drill rigs, and generators (which run mainly during the day). Fires are rare in the area surrounding the concession, as there has been almost no burning to clear land for agriculture or

the raising of livestock in this region. Dust levels in the prospecting areas and along trails are low due to the high humidity and frequent rainfalls, except for a few isolated, localized, and heavily-trafficked sections of road in dry seasonal conditions.

4.5 Hydrology

4.5.1 Surface Waters

The mine site area is drained by the Cuyuni River, which borders the site to the north, along with several associated tributaries, including the Gold River located to the east of the site. With a length of approximately 750 km, the Cuyuni River extends in a general west-east direction from its headwaters in Venezuela to the Essequibo River in Guyana. The basin covers an area of approximately 53,500 square kilometers (km²) (AMEC, 2009). A hydrologic map showing the locations of the Cuyuni River and associated tributaries in relation to the project site is provided on **Figure 4.5-1**.

The portion of the site where surface and underground mining is planned (i.e., north-central portion of the concession near the Cuyuni River) has been partially cleared over the years to facilitate prior mining and exploratory drilling operations. Limited surface water runoff into the Cuyuni River is expected in this area. However, based on the presence of a thick forest canopy over much of the remaining portions of the site and general overall soil conditions, it is anticipated that infiltration of rainfall into the ground is a more significant process than storm water runoff into the Cuyuni River and its tributaries. As a result, flows within the streams and creeks traversing the site are more likely the result of groundwater discharge to surface water bodies than from surface water runoff. Historical daily flow records for the Cuyuni River are available for two hydrometric stations, referred to as Akarabisi (data available from 1967–1977) and Kamaria Falls (data available from 1947–1981, 1987, and 1989), which are separated by a distance of about 240 km and located along the Cuyuni River upstream and downstream of the site, respectively. **Figure 4.5-2** is a graphic representation of mean daily flows for the Kamaria Falls and Akarabisi stations for the period 1947–1989, based on Kamaria Falls data from 1947–1981, 1987, and 1989, and Akarabisi data from 1967–1977 (MWH, 2008). **Figure 4.5-3** depicts mean daily flows at the Aurora mine location, also for the period 1947–1989. Flows were calculated by scaling the downstream Kamaria Falls flow data based on the relative size of the drainage basins at Aurora and Kamaria Falls (MWH, 2008).

Over the period in which readings were taken concurrently at both stations (i.e., 1967 to 1977), the mean annual flow at the upstream station (1,375 cubic meters per second [m³/s]) exceeds the mean annual flow at the downstream station (1,259 m³/s). For some years, the mean annual flows at the upstream station exceed those at the downstream station by up to 40%. No specific explanations exist for this discrepancy based on the drainage pattern of the river basin. However, considering the low runoff coefficient implied by the downstream flow data, the mean annual flow data from the upstream station is probably more representative of the actual flow conditions at the Project site (AMEC, 2009).

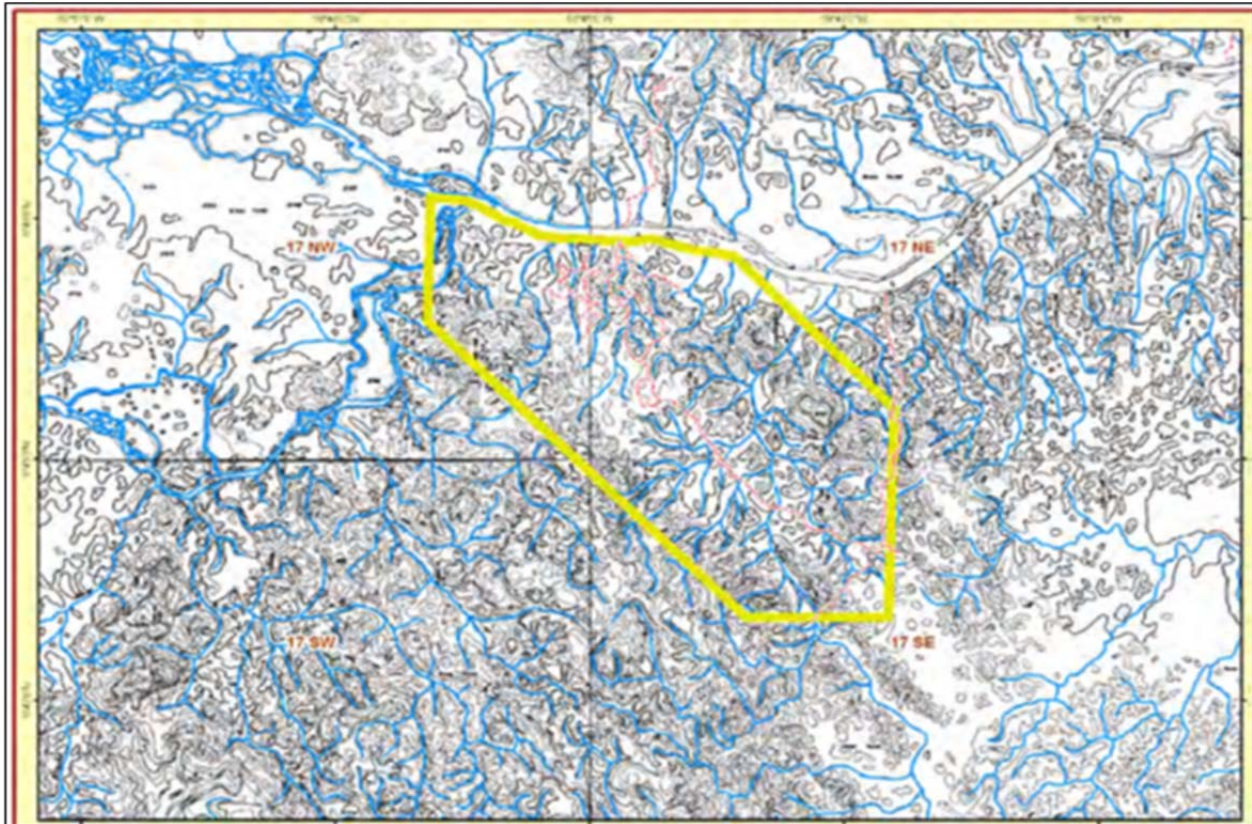


Figure 4.5-1: Hydrologic Map of the Aurora Concession (yellow polygon) and Surrounding Area.
Source: GGI

In a 2011 study, Montgomery Watson Harza (MWH) also used the Kamaria Falls data and adjusted it using a basin ratio (a ratio of the area drained by a basin at a given point to the flow of water at that point) to obtain a flow duration curve for the Cuyuni River at Aurora (see **Figure 4.5-4**). They then selected a 37 value series of maximum annual daily flow and made an extreme event analysis. The results were:

- Mean annual daily flow = 1,000 m³/s
- 70% exceedance flow = 470 m³/s
- 10,000-yr discharge = ~8,000 m³/s

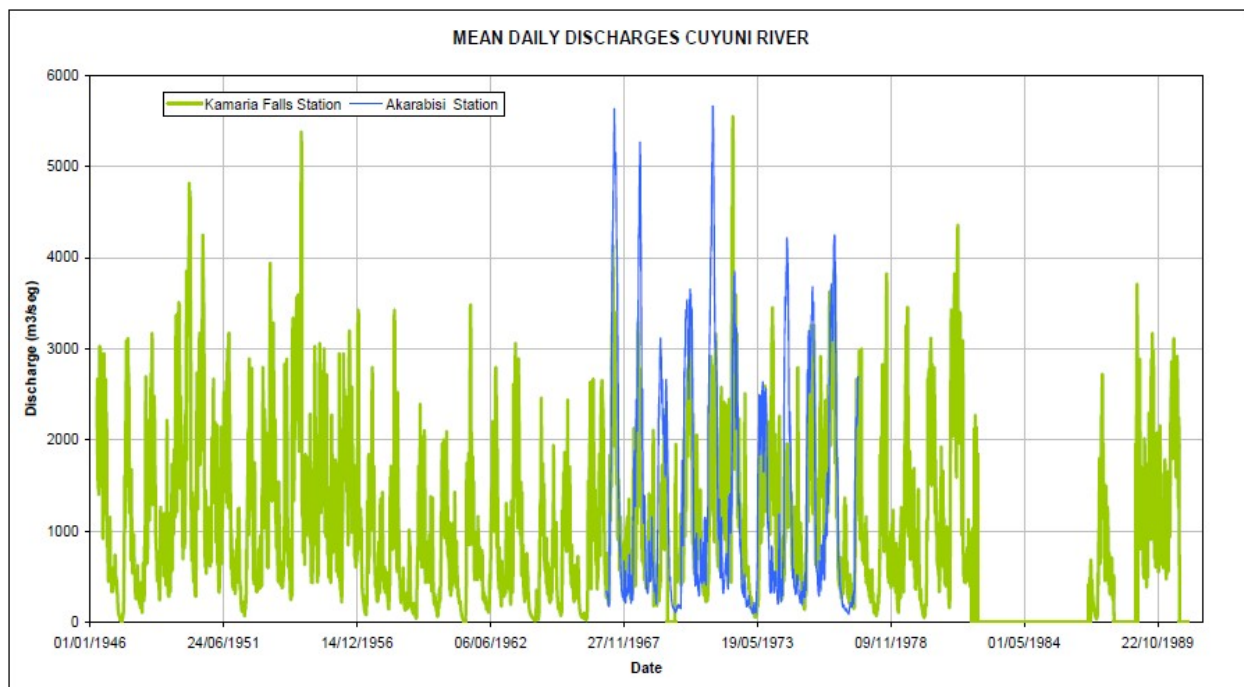


Figure 4.5-2: Mean Daily Flows (m^3/s) for the Kamaria Falls and Akarabisi Stations for the Period 1947–1989 (MWH, 2008)

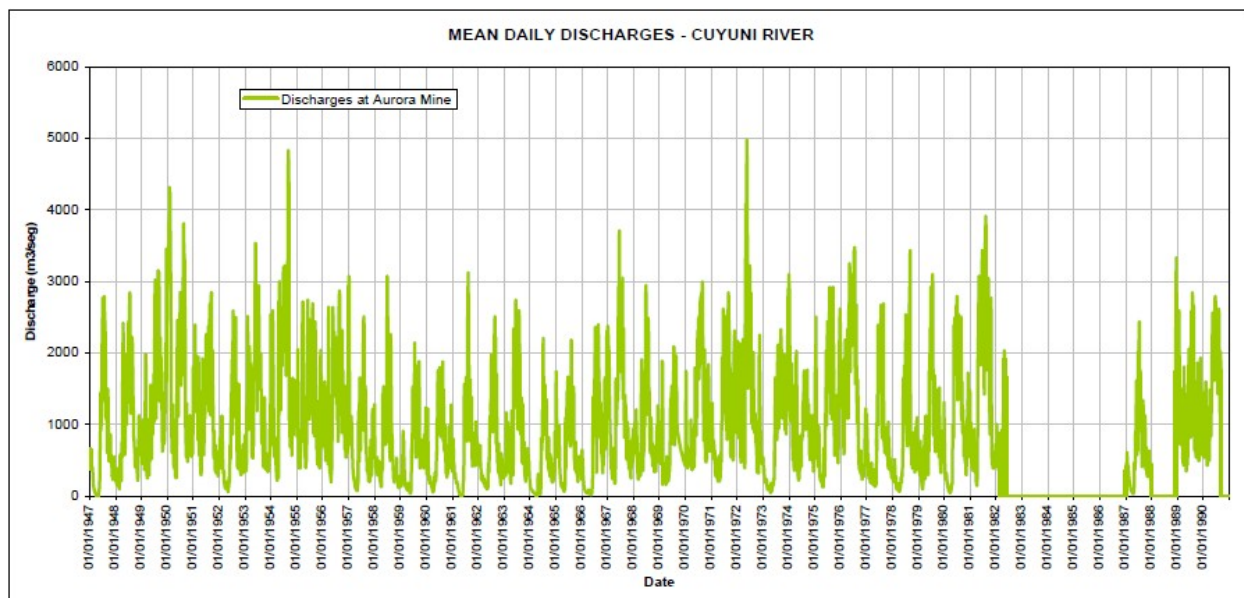


Figure 4.5-3: Mean Daily Flows (m^3/s) at the Aurora Mine Location for the Period 1947–1989 (MWH, 2008)

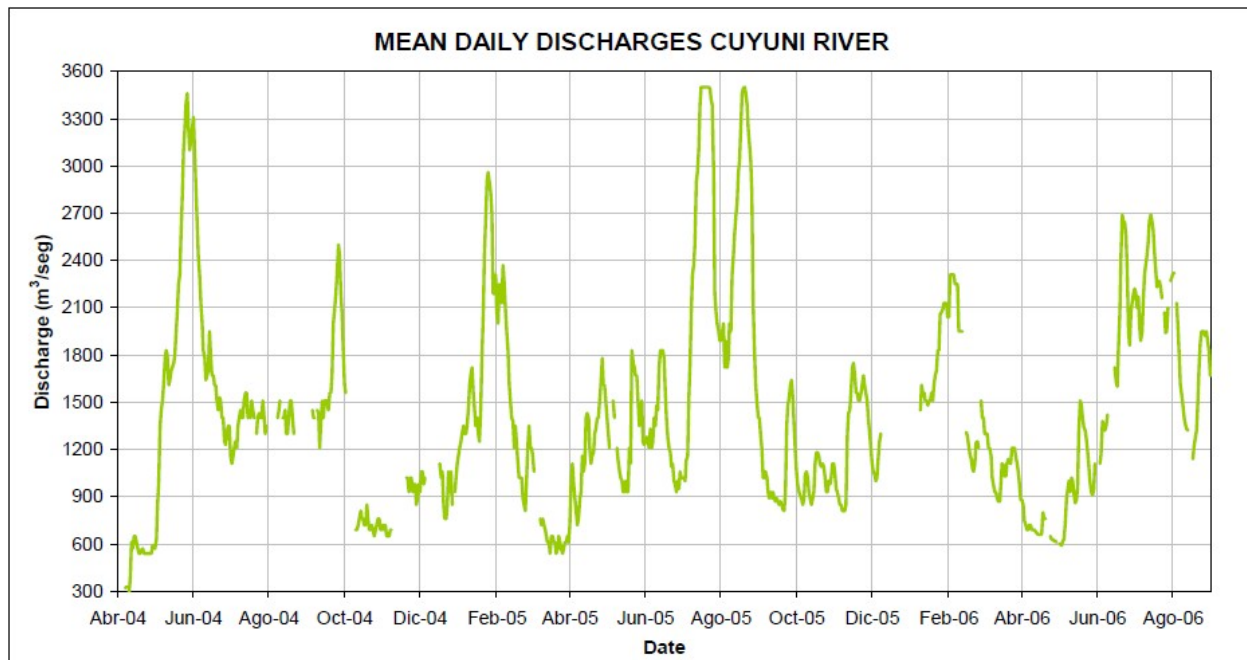


Figure 4.5-4: Mean Daily Flows (m³/s) of the Cuyuni River at the Aurora Mine Location for the Period April 2004 – August 2006 [Note: Flow data were calculated using a Rating Curve relating depth to flow rate (MWH 2008)]

4.5.2 Groundwater

Up until 2011, a total of eight groundwater monitoring wells had been drilled at the Project site. The locations of the existing monitoring wells are illustrated in **Figure 4.5-5**. Installed in March 2006, five of the monitoring wells (MW-1 through MW-5) are located within an area referred to as the Golden Mile and extend to depths of approximately 6 m below grade. Monitoring wells were installed in 100-mm diameter borings and consist of 50-mm diameter polyvinyl chloride (PVC) casing with 3 m of PVC No. 10 slotted screen surrounded by a sand pack. The geographic locations of these wells are as follows:

- MW-1 59°44.5'W, 6°47.7'N
- MW-2 59°45.43'W, 6°46.8'N
- MW-3 59°44.5'W, 6°46.8'N
- MW-4 59°45.43'W, 6°47.7'N
- MW-5 59°44.95'W, 6°47.25'N

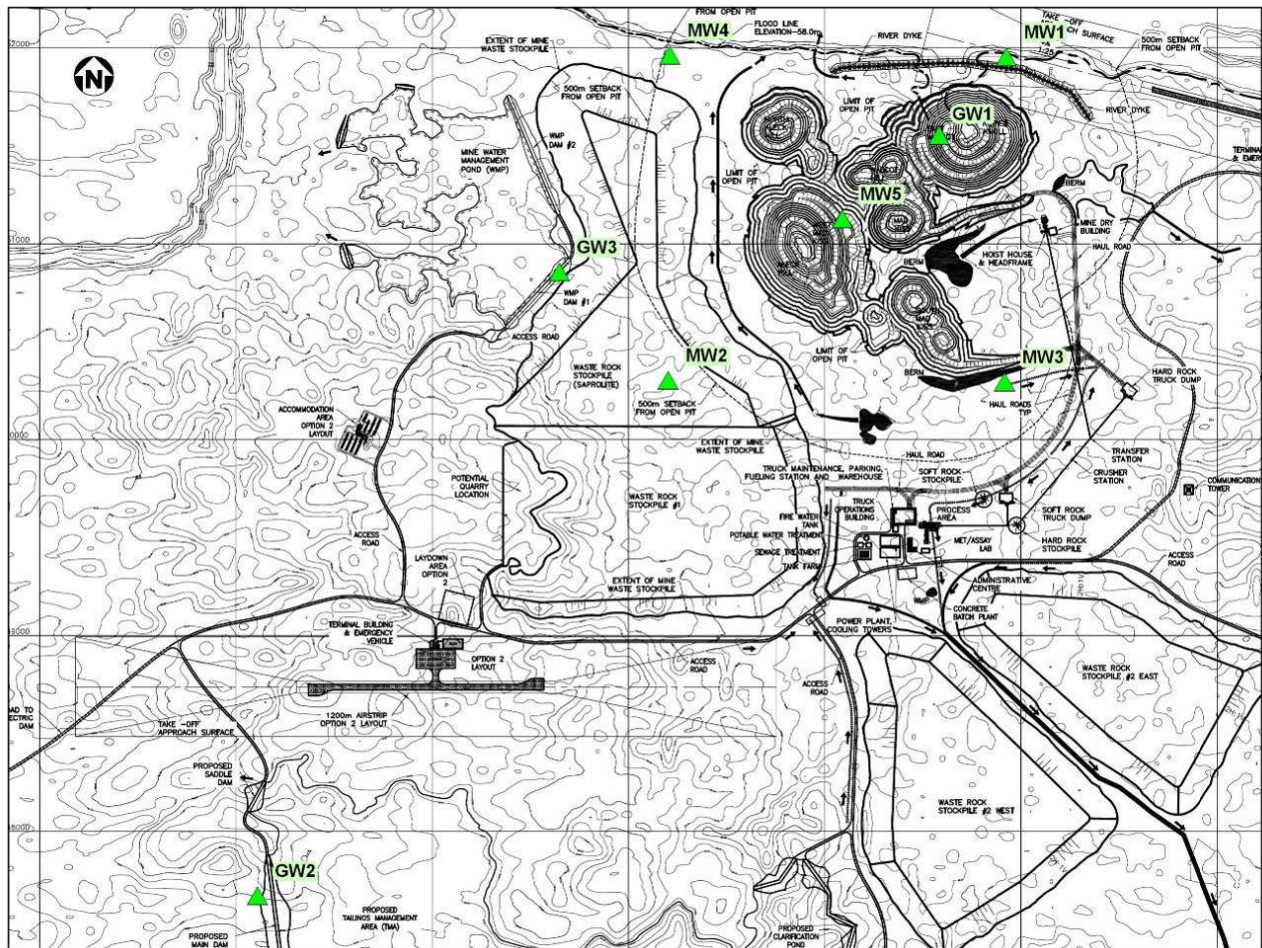


Figure 4.5-5: Groundwater Monitoring Well Locations (indicated by green triangles on map)

Source: AMEC (Basemap) and ERM (2010) [Note: figure shows early configuration of project features per (AMEC, 2009)]

During the previous feasibility studies conducted by AMEC, approximate footprints were established for the following facilities:

- river dyke;
- TMA; and,
- a water management pond (MWP).

Groundwater monitoring wells were installed below these areas to provide data on baseline groundwater quality.

As previously noted in Section 4.1 and **Figure 4.1-1**, the overall footprint of the mine has been significantly reduced since the AMEC feasibility study (AMEC, 2009; **Figure 4.5-5**, and the TMA and water management features (fresh water pond [FWP] and MWP) have been consolidated in locations immediately south of the pit areas. Reduced mine footprint notwithstanding, the original data from the 2009 are considered to be highly representative of site conditions with the mine in its final design configuration.

The groundwater monitoring wells in these areas were respectively designated as GW-1, GW-2, and GW-3 during the 2009 sampling event, and were installed by drilling an NQ-sized (i.e., 75.7 mm outside diameter) borehole to approximately 0.6 m below the required depth of each well. The required depth of each well was based on the actual depth of the water table and the type of soils encountered. A sand bed was then placed in the lower 0.6 m of the borehole and a 3-m long 25-mm PVC No. 10 slotted screen was installed within the borehole annulus. The screen was then connected to a 25-mm diameter riser pipe which extended to 1 m above the ground surface. A sand pack was placed around the screen and was extended to a point approximately 0.6 m above the top of the screened interval. A bentonite/cement grout mix was then placed above this sand pack up to the ground level to prevent the migration of surface contaminants through the borehole annulus.

The depth to groundwater was measured in each well and recorded during the groundwater sampling activities. Clean dedicated bailers were used to collect groundwater samples from each well. In each instance, monitoring wells were purged of three volumes of standing water prior to sampling.

Based on groundwater monitoring conducted in 2006 and 2007, shallow groundwater exists within the unconsolidated overburden at depths ranging from approximately 1 m to 4 m below grade. Groundwater level data for monitoring wells MW-1 through MW-5 along with monitoring dates are provided in **Table 4.5-1**.

Table 4.5-1: Depth to groundwater in meters (m)				
Well No.	January – February 2006	July 2006	October 2006	February – March 2007
MW-1	2.44	2.18	2.90	3.25
MW-2	2.15	1.09	3.10	3.52
MW-3	Dry	1.96	2.95	3.38
MW-4	Dry	2.03	3.15	3.76
MW-5	2.44	1.07	2.62	3.08

Source: Data provided by GGI.

Rising head in situ hydraulic conductivity tests were also conducted in each of these wells during the 2006 and 2007 groundwater monitoring events. Based on the results of the aquifer testing, hydraulic conductivities range from 3.49×10^{-7} to 8.36×10^{-5} centimeters per second (cm/s) (AMEC, 2009). A summary of the hydraulic conductivities for each monitoring well is provided in **Table 4.5-2**.

Table 4.5-2: Summary of hydraulic conductivities in centimeters per second (cm/s)

Well No.	January – February 2006	July 2006	October 2006	February – March 2007
MW-1	7.9×10^{-6}	1.34×10^{-6}	5.3×10^{-6}	3.8×10^{-6}
MW-2	8.36×10^{-5}	4.70×10^{-7}	1.44×10^{-5}	8.76×10^{-6}
MW-3	1.35×10^{-5} (Falling Head)	9.28×10^{-7}	6.8×10^{-6}	3.8×10^{-6}
MW-4	2.18×10^{-5} (Falling Head)	3.49×10^{-7}	6.3×10^{-6}	4.8×10^{-6}
MW-5	9.7×10^{-6}	2.71×10^{-6}	1.5×10^{-5}	9.7×10^{-6}

As part of the conceptual design for the pit dewatering systems, seepage into the proposed open-pit mine was estimated using a 3-D groundwater flow model (MODFLOW) that assumed inflow into the pits from three potential sources (i.e., groundwater flow from adjoining bedrock, leakage from saturated overburden/saprolite induced by the pit dewatering activities, and groundwater flow from the Cuyuni River under a losing stream scenario). The model assumed steady-state conditions, corresponding to long-term stabilized groundwater flow into a fully developed pit (AMEC, 2009).

Based on the initial modeling results, the estimated seepage rates into the open pit were approximately 4,000 cubic meters per day (m^3/d) under the base case scenario (i.e., assuming a bulk hydraulic conductivity of 2×10^{-4} cm/s) and about 14,000 m^3/d under the simulated conservative scenario (i.e., assuming a bulk hydraulic conductivity of 1×10^{-3} cm/s). The estimated groundwater inflow to the proposed Rory's Knoll underground mine workings (i.e., shaft, drifts, ramp and stopes) increases the predicted seepage rate by approximately 2,000 m^3/d . Based on these estimates, the total seepage rate is expected to range from about 6,000 m^3/d (base case scenario) to 16,000 m^3/d (conservative scenario) (AMEC, 2009).

4.5.3 2011 Investigation

The 2009 groundwater hydrology work was focused primarily on development of estimates of groundwater inflow from the Cuyuni River into the mine pit. Consequently all wells were located on the north side of the pit and with the exception of one well which was at the perimeter of the East Wolcott pit. Water levels were recorded for several points, within the footprint of the area proposed, to be developed into the mine site during the geotechnical investigations of the mine site. The water levels, however, were not based on isolation of the unconsolidated saprolite and overburden zone from the underlying rock and may be reflective of groundwater levels in bedrock or saprolite only. The information was therefore only partially usable to develop the regional groundwater flow patterns at the site, to the level requested by the IFC, and additional studies were required.

On July 29, 2011, a well installation program was initiated at Aurora to fill the data gaps required to ensure a proper definition of the regional groundwater flow regime at the site. Field checks revealed that most of the wells installed during the original geotechnical investigation program were screened in the saprolite; the sole exception being one well at Aurora (BH09-11) near the

pit perimeter. The decision was therefore made to install four monitoring wells in bedrock and a single monitoring well in saprolite.

Four packer tests and one rising head (slug) hydraulic conductivity test were conducted at Aurora using five new monitoring wells (**Table 4.5-3**). Packer tests were conducted at locations BH09-RK-RMP-01A DW, BH09-29-DW, BH09-21-DW and BH09-25-DW. The single slug test was conducted at BH09-11-SW.

Table 4.5-3 Locations, depths, and identification of well nests at Aurora and formation in which each is screened						
Location	Borehole/Monitoring	Coordinates UTM Zone 21N	Screened Formation	Depth (m)	Type of Monitoring	Formation
Mine Pit	BH09-RK-RMP-01A	196734 751731			Standpipe Piezometer	Saprolite
	BH09-RK-RMP-01A-DW	196736 751730	Bedrock	18.1	Standpipe Piezometer	Bedrock
Mine Pit	BH09-08A	197031 751699			Standpipe Piezometer	Saprolite
	BH09-08B	197021 751705			Vibrating Wire Piezometer	Bedrock
	BH09-11-SW	195598 750896	Saprolite	27	Standpipe Piezometer	Saprolite
	BH09-11	195588 750901			Vibrating Wire Piezometer	Bedrock
Water Management Pond	BH09-29	194557 751397			Standpipe Piezometer	Saprolite
	BH09-29-DW	194558 751415	Bedrock	25.5	Standpipe Piezometer	Bedrock
Tailings Management Pond	BH09-21	193201 747488			Standpipe Piezometer	Saprolite
	BH09-21-DW	193204 747470	Bedrock	30.6	Standpipe Piezometer	Bedrock
Clarification Pond	BH09-25	195764 747761			Standpipe Piezometer	Saprolite
	BH09-25-DW	195767 747762	Bedrock	25.5	Standpipe Piezometer	Bedrock

At Aurora, the groundwater levels in the saprolite and bedrock differed at the same well nest, which is indicative of the absence of direct hydraulic connection between these strata. The saprolite stratum acts as a confining layer for groundwater flow in the bedrock.

The partial flow net and groundwater elevations indicate that flow in the saprolite zone is primarily to northeast and northwest at the site towards the Cuyuni River (**Table 4.5-4**). The

steep gradient in the area adjacent to the Cuyuni River indicates that flow in this area may be highly dependent on and influenced by water levels in the river. Flow in the bedrock zone replicates the flow in the saprolite zone and is primarily to northeast and northwest at the site towards the Cuyuni River.

Table 4.5-4: Groundwater elevations and hydraulic conductivity in centimeters per second (cm/s) for each screened geologic formation at Aurora [Note: assumes early configuration of project features per (AMEC, 2009)]				
Locations	Borehole/Monitoring Well ID		Groundwater Elevation (m)	Hydraulic Conductivity (cm/s)
Mine Pit	BH09-RK-RMP-01A	Saprolite	48.994	NA
Mine Pit Perimeter	BH09-08A	Saprolite	48.44	1.90E-05
	BH09-11-SW	Saprolite	58.186	4.70E-05
Water Management Pond	BH09-29	Saprolite	49.71	1.70E-05
Tailings Management Pond	BH09-21	Saprolite	65.788	2.30E-05
Clarification Pond	BH09-25	Saprolite	67.136	1.00E-05
River Dyke	BH09-03A	Saprolite	48.084	1.10E-03
	BH09-03B	Saprolite	48.472	3.90E-06
Mine Pit	BH09-RK-RMP-01A-DW	Bedrock	48.994	8.70E-04
	BH09-08B	Bedrock	44.549	7.80E-06
Mine Pit Perimeter	BH09-11	Bedrock	55.926	5.00E-03
Water Management Pond	BH09-29-DW	Bedrock	50.48	4.14E-05
Tailings Management Pond	BH09-21-DW	Bedrock	66.888	9.60E-06
Clarification Pond	BH09-25-DW	Bedrock	67.306	NA
River Dyke	BH09-05	Weathered	45.04	NA

The propensity for flow between the saprolite and bedrock was determined by calculating the vertical hydraulic gradients between the two formations. Since flow in the bedrock is influenced primarily by the fracture frequency and spacing, it is highly likely that at depths less than 25 m there is an upwards hydraulic gradient between the bedrock and saprolite.

The hydraulic conductivity of the saprolite at Aurora was determined to be relatively constant and equated to approximately 10^{-5} cm/s., the sole exception being the hydraulic conductivity of saprolite in the vicinity of the river dyke which ranged from 10^{-3} to 10^{-6} cm/s (**Table 4.5-4**). The

hydraulic conductivity of the bedrock was variable and ranged from approximately 10^{-3} cm/s to 10^{-5} cm/s with the exception of the point in the vicinity of the clarification pond, where no water losses occurred during the packer test. The variation of these values is indicative of flow in the bedrock being influenced by fracture frequency and spacing, the higher hydraulic conductivity being likely reflective of greater fracture frequency and spacing.

4.6 Water Quality

Surface water quality within the Cuyuni River has been impacted historically by upstream ASM activities, in Venezuela (Nico & Taphorn, 1994) and in the reach of the river immediately upstream and downstream from the Aurora concession (Sidlauskas, 2011). ASM activities have increased surface water turbidity and concentrations of suspended solids in the Cuyuni River and its tributaries. Mercury contamination of surface water, sediments, and fish has also been documented in the Cuyuni River basin.

In 2006 and 2007, surface water samples were collected from locations on the Cuyuni River, and Gold River and from an unnamed tributary of the Cuyuni River immediately downstream of Devil's Hole. The sampling was conducted at times coincident with the four seasons in Guyana in order to better understand water quality in both wet and dry seasons. The unnamed tributary of the Cuyuni River and Gold River are upstream and downstream of the Project area, respectively. Cuyuni River samples were collected immediately north of the area identified as the Golden Mile. Surface water samples from the unnamed tributary are consequently indicative of background water quality for smaller creeks that crisscross the project site. Surface water samples from both Gold River and Cuyuni River would be indicative of baseline water quality prior to the commencement of mining operations.

The surface water sampling results are provided in **Tables 4.6-1** through **4.6-8**, each table representing different sampling dates (2006 through 2011). IFC parameters for effluent from mining operations (see Table 1, IFC, 2007) are also presented in the table for comparison purposes. Concentrations are provided in milligrams per liter (mg/L) unless specified otherwise. As shown in the data, total iron is the only parameter that exceeded the standards. Total iron concentrations ranged from 0.5 to 9.11 mg/L.

Table 4.6-1: Surface water analytical results in milligrams per liter (mg/L), February 10, 2006					
Parameter	Units	Unnamed Creek	Cuyuni River	Gold River	IFC EHS Guidelines for Mining (IFC 2007)
Biochemical Oxygen Demand	mg/L	< 1	< 1	< 1	50
Cyanide (free)	mg/L	< 0.005	< 0.005	< 0.005	0.1
Cyanide (total)	mg/L	< 0.005	< 0.005	< 0.005	1
pH		7.23	7.3	7.63	6 to 9
Total Suspended Solids	mg/L	21	27	13	50
Arsenic	mg/L	< 0.001	< 0.001	< 0.001	0.1
Cadmium	mg/L	< 0.0001	< 0.0001	< 0.0001	0.05
Chromium	mg/L	< 0.001	0.002	0.001	NA
Copper	mg/L	< 0.001	< 0.001	< 0.001	0.3

Table 4.6-1: Surface water analytical results in milligrams per liter (mg/L), February 10, 2006

Parameter	Units	Unnamed Creek	Cuyuni River	Gold River	IFC EHS Guidelines for Mining (IFC 2007)
Hexavalent Chromium	mg/L	< 0.05	< 0.05	< 0.05	0.1
Iron, Total	mg/L	1.65	9.11	3.08	2
Lead	mg/L	< 0.001	< 0.001	< 0.001	0.2
Mercury	mg/L	< 0.0001	< 0.0001	< 0.0001	0.002
Nickel	mg/L	< 0.005	< 0.005	< 0.005	0.5
Zinc	mg/L	0.01	0.01	< 0.01	0.5
Oil and Grease, Mineral	mg/L	< 1.0	< 1.0	< 1.0	NA
Oil and Grease, Non-Mineral	mg/L	< 4.0	< 4.0	< 4.0	NA
Oil and Grease, Total	mg/L	< 5.0	< 5.0	< 5.0	10

Table 4.6-2: Surface water analytical results in milligrams per liter (mg/L), July 6, 2006

Parameter	Units	Unnamed Creek	Cuyuni River	Gold River	IFC EHS Guidelines for Mining (IFC 2007)
Biochemical Oxygen Demand	mg/L	1	< 1	< 1	50
Cyanide (free)	mg/L	0.005	< 0.005	< 0.005	0.1
Cyanide (total)	mg/L	0.005	< 0.005	< 0.005	1
pH		--	7.38	7.48	6 to 9
Total Suspended Solids	mg/L	2	32	45	50
Arsenic	mg/L	0.001	< 0.001	< 0.001	0.1
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	0.05
Chromium	mg/L	0.001	< 0.001	0.002	NA
Copper	mg/L	0.001	< 0.001	< 0.001	0.3
Hexavalent Chromium	mg/L	0.05	< 0.05	< 0.05	0.1
Iron, Total	mg/L	0.03	2.01	8.67	2
Lead	mg/L	0.001	< 0.001	< 0.001	0.2
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	0.002
Nickel	mg/L	0.005	< 0.005	< 0.005	0.5
Zinc	mg/L	0.01	< 0.01	< 0.01	0.5
Oil and Grease, Mineral	mg/L	1	< 1.0	< 1.0	NA
Oil and Grease, Non-Mineral	mg/L	4	< 4.0	< 4.0	NA
Oil and Grease, Total	mg/L	1	< 1	< 1	10

Table 4.6-3: Surface water analytical results in milligrams per liter (mg/L), October 12, 2006

Parameter	Units	Unnamed Creek	Cuyuni River	Gold River	IFC EHS Guidelines for Mining (2007)
Biochemical Oxygen Demand	mg/L	<1	<1	<1	50
Cyanide (free)	mg/L	0.011	0.008	0.009	0.1
Cyanide (total)	mg/L	--	--	--	1
pH		6.63	6.49	6.42	6 to 9
Total Suspended Solids	mg/L	44	17	37	50
Arsenic	mg/L	<0.001	<0.001	<0.001	0.1
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	0.05
Chromium	mg/L	0.002	0.003	0.003	NA
Copper	mg/L	0.002	0.002	0.002	0.3
Hexavalent Chromium	mg/L	<0.05	<0.05	<0.05	0.1
Iron, Total	mg/L	0.50	0.55	0.68	2
Lead	mg/L	<0.001	<0.001	<0.001	0.2
Mercury	mg/L	<0.0001	<0.0001	<0.0001	0.002
Nickel	mg/L	<0.005	<0.005	<0.005	0.5
Zinc	mg/L	<0.01	<0.01	<0.01	0.5
Oil and Grease, Mineral	mg/L	<1	<1	<1	NA
Oil and Grease, Non-Mineral	mg/L	<4	<4	<4	NA
Oil and Grease, Total	mg/L	<5	<5	<5	10

Table 4.6-4: Surface water analytical results in milligrams per liter (mg/L), March 4, 2007

Parameter	Units	Unnamed Creek	Cuyuni River	Gold River	IFC EHS Guidelines for Mining (2007)
Biochemical Oxygen Demand	mg/L	1	1	1	50
Cyanide (free)	mg/L	<0.25	<0.25	<0.25	0.1
Cyanide (total)	mg/L	<0.25	<0.25	<0.25	1
pH		7.27	7.41	7.25	6 to 9
Total Suspended Solids	mg/L	37	24	18	50
Arsenic	mg/L	<0.001	<0.001	<0.001	0.1
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	0.05
Chromium	mg/L	0.001	0.003	0.001	NA
Copper	mg/L	0.003	0.003	0.001	0.3
Hexavalent Chromium	mg/L	<0.05	<0.05	<0.05	0.1
Iron, Total	mg/L	1.00	2.14	2.57	2
Lead	mg/L	<0.001	<0.001	<0.001	0.2
Mercury	mg/L	<0.0001	<0.0001	<0.0001	0.002
Nickel	mg/L	<0.005	<0.005	<0.005	0.5

Table 4.6-4: Surface water analytical results in milligrams per liter (mg/L), March 4, 2007

Zinc	mg/L	<0.01	<0.01	<0.01	0.5
Oil and Grease, Mineral	mg/L	<1	<1	<1	NA
Oil and Grease, Non-Mineral	mg/L	<4	<4	<4	NA
Oil and Grease, Total	mg/L	<5	<5	<5	10

In 2009, additional surface water and sediment sampling was conducted along the Cuyuni River to assess baseline surface water and sediment quality conditions. The samples were collected from the following locations:

- SW1/SD1—Collected from the Julian Ross Itabu, approximately 500 m upstream of the Cuyuni River, upstream of the Project site (E193105, N752493);
- SW2/SD2—Collected in the vicinity of the Aurora Camp at the Project site (E196438, N751628); and,
- SW3/SD3—Collected in the vicinity of the mouth of Aranka Creek downstream of the Project site (E210060, N755738).

Surface water and sediment sampling locations from 2009 are provided on **Figure 4.6-1**; surface water and sediment analytical results from 2009 are provided in **Table 4.6-5 and 4.6-6**; and surface water sampling results were compared to IFC (2007) standards. No IFC (2007) standards exist for sediment.

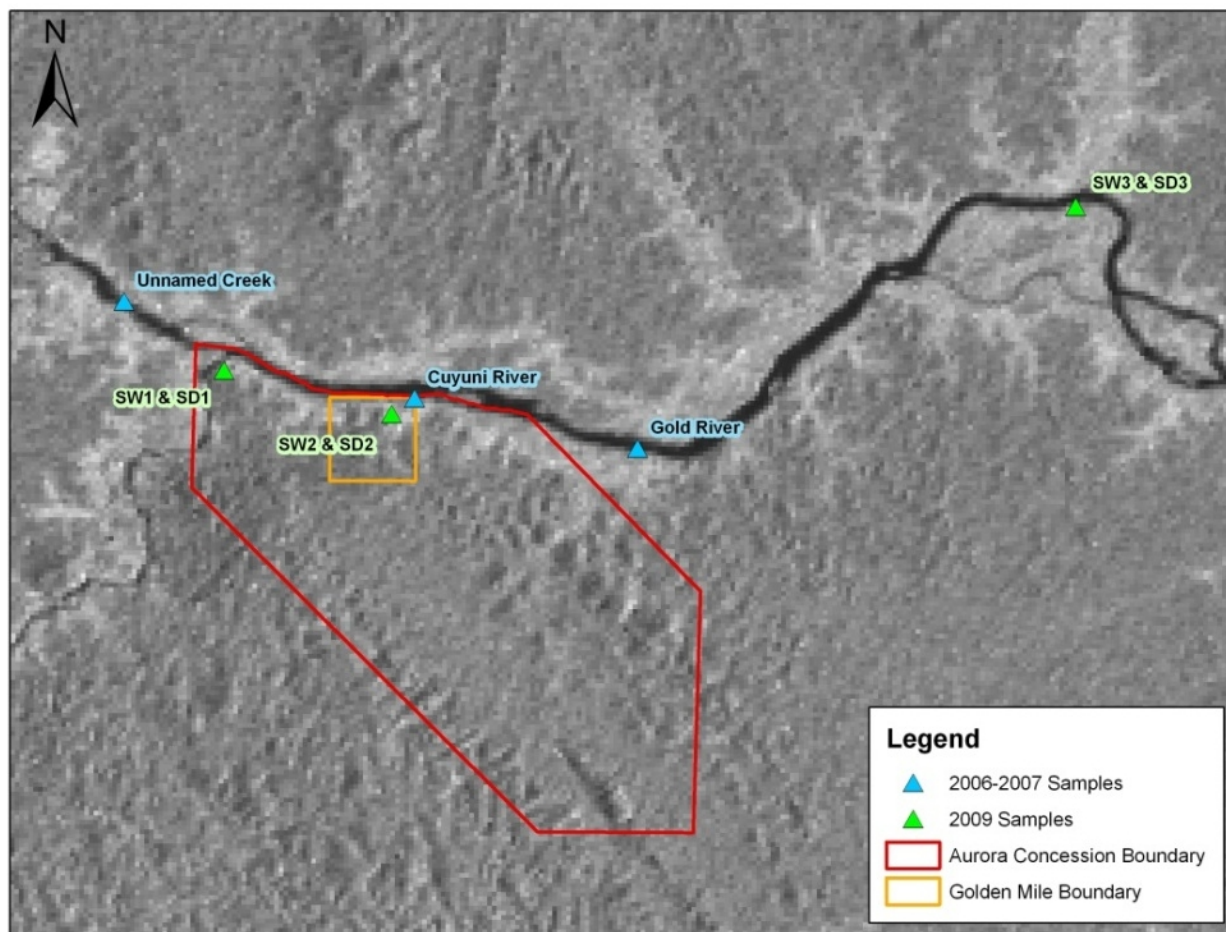


Figure 4.6-1: 2006-2007 and 2009 Surface Water and Sediment Sampling Locations. Source: ERM, 2010.

Table 4.6-5: 2009 Surface water analytical results (milligrams per liter = mg/L, micro Siemens per centimeter = uS/cm, Nephelometric Turbidity Units = NTU)

Parameter	Units	SW1	SW2	SW3	IFC EHS Guidelines for Mining (IFC 2007)
Alkalinity as CaCO ₃	mg/L	7	12	11	NA
Chloride	mg/L	3	4	5	NA
Conductivity	uS/cm	25	26	28	NA
Cyanide (free)	mg/L	<0.10	<0.10	<0.10	0.1
Cyanide (total)	mg/L	<0.10	<0.10	<0.10	1
Fluoride	mg/L	<0.10	<0.10	<0.10	NA
N-NO ₂ (Nitrite)	mg/L	<0.10	<0.10	<0.10	NA
N-NO ₃ (Nitrate)	mg/L	0.11	0.13	0.13	NA
pH		6.93	6.72	6.74	6 to 9
Phenols	mg/L	<0.001	<0.001	<0.001	0.5
Sulphate	mg/L	<1	<1	<1	NA

Table 4.6-5: 2009 Surface water analytical results (milligrams per liter = mg/L, micro Siemens per centimeter = uS/cm, Nephelometric Turbidity Units = NTU)

Parameter	Units	SW1	SW2	SW3	IFC EHS Guidelines for Mining (IFC 2007)
Total Dissolved Solids (COND - CALC)	mg/L	16	17	18	NA
Total Kjeldahl Nitrogen	mg/L	0.55	0.52	0.33	NA
Total Phosphorus	mg/L	0.05	<0.1	0.35	NA
Total Suspended Solids	mg/L	22	50	264	50
Turbidity	NTU	46.0	67.4	>100	NA
HCO ₃ as CaCO ₃	mg/L	7	12	11	NA
Calcium	mg/L	1	1	2	NA
Magnesium	mg/L	<1	<1	<1	NA
Potassium	mg/L	<1	<1	<1	NA
Sodium	mg/L	<2	<2	2	NA
Aluminum	mg/L	2.3	3.5	4.1	NA
Antimony	mg/L	<0.01	<0.01	<0.01	NA
Arsenic	mg/L	<0.05	<0.05	<0.05	0.1
Barium	mg/L	0.85	0.03	0.03	NA
Beryllium	mg/L	<0.01	<0.01	<0.01	NA
Boron	mg/L	<0.1	<0.1	<0.1	NA
Cadmium	mg/L	<0.01	<0.01	<0.01	0.05
Chromium	mg/L	<0.02	<0.02	<0.02	NA
Cobalt	mg/L	<0.005	<0.005	<0.005	NA
Copper	mg/L	<0.01	<0.01	0.02	0.3
Iron	mg/L	2.4	3.8	4.0	2
Lead	mg/L	<0.01	<0.01	<0.01	0.2
Manganese	mg/L	0.03	0.05	0.08	NA
Mercury	mg/L	<0.0001	<0.0001	<0.0001	0.002
Molybdenum	mg/L	<0.01	<0.01	<0.01	NA
Nickel	mg/L	<0.01	<0.01	<0.01	0.5
Selenium	mg/L	<0.05	<0.05	<0.05	NA
Silicon	mg/L	<1	<1	<1	NA
Silver	mg/L	<0.01	<0.01	<0.01	NA
Strontium	mg/L	<0.05	<0.05	<0.05	NA
Thallium	mg/L	<0.01	<0.01	<0.01	NA
Titanium	mg/L	<0.1	<0.1	<0.1	NA
Vanadium	mg/L	<0.05	<0.05	<0.05	NA
Zinc	mg/L	<0.05	<0.05	<0.05	0.5
Oil & Grease - Mineral	mg/L	<1	<1	<1	NA
Oil & Grease - Non-mineral	mg/L	<1	11	<1	NA
Oil & Grease - Total	mg/L	<1	11	<1	10

Table 4.6-6: 2009 sediment analytical results.

Parameter	Units	SD1	SD2	SD3
Cyanide (free)	µg/g	0.28	0.27	0.17
Loss on Ignition (@550C)	%	9.45	7.58	6.68
Total Organic Carbon	%	1.57	1.35	2.05
Calcium	µg/g	2020	1090	1070
Magnesium	µg/g	1140	741	344
Potassium	µg/g	300	207	222
Sodium	µg/g	<100	<100	122
Aluminum	µg/g	20400	16100	7010
Antimony	µg/g	<1	<1	<1
Arsenic	µg/g	<1.0	1.0	2.1
Barium	µg/g	88	69	47
Beryllium	µg/g	<1	<1	<1
Cadmium	µg/g	<0.5	<0.5	<0.5
Chromium	µg/g	87	71	74
Cobalt	µg/g	14	12	14
Copper	µg/g	21	18	49
Iron	µg/g	26000	23600	24300
Lead	µg/g	10	10	5
Manganese	µg/g	203	180	385
Mercury	µg/g	0.2	0.2	0.1
Molybdenum	µg/g	<1	<1	<1
Nickel	µg/g	20	15	8
Selenium	µg/g	<1	<1	<1
Silver	µg/g	<0.2	<0.2	<0.2
Strontium	µg/g	9	6	6
Thallium	µg/g	<1	<1	<1
Vanadium	µg/g	95	80	66
Zinc	µg/g	44	36	27
Oil & Grease - Mineral	µg/g	<100	<100	<100
Oil & Grease - Non-mineral	µg/g	580	<100	<100
Oil & Grease - Total	µg/g	580	<100	<100

As shown in **Table 4.6-5**, total suspended solids (TSS), iron, and oil and grease were detected in surface water samples at concentrations above the IFC standards. The detection of oil and grease at elevated levels in sample SW2 could be attributed to residual petroleum hydrocarbon impacts from the former gold exploration and drilling operations at the Aurora Camp.

During the groundwater investigation conducted in 2011, surface sediment samples were recovered from five points at Aurora. Sediment samples were also recovered from stream beds at points coincident with the points at which surface water samples were recovered. Both surface water and sediment samples were tested by Exova Laboratories. Flow parameters were

also recorded for each stream from which surface water samples. None of the parameters sampled in the groundwater, surface water, and sediment samples exceeded IFC (2007) effluent standards.

Table 4.6-7: Results of analytical tests on surface water samples at Aurora (2011). MRL – minimum recordable limit (milligrams per liter = mg/L, micro Siemens per centimeter = uS/cm, Nephelometric Turbidity Units = NTU).

Parameter	Units	MRL	ASP-01	ASP-02	ASP-03	ASP-04
Alkalinity as CaCO ₃	mg/L	5	12	18	25	28
Bromide	mg/L	0.25	<0.25	<0.25	<0.25	<0.25
Chloride	mg/L	1	6	5	4	6
Conductivity	uS/cm	5	36	44	53	63
Fluoride	mg/L	0.1	<0.10	<0.10	<0.10	<0.10
N-NH ₃ (Ammonia)	mg/L	0.02	<0.02	<0.02	<0.02	<0.02
N-NO ₂ (Nitrite)	mg/L	0.1	<0.10	<0.10	<0.10	<0.10
N-NO ₃ (Nitrate)	mg/L	0.1	0.1	0.1	0.15	0.12
O-PO ₄ (Ortho-Phosphate)	mg/L	0.03	<0.03	0.12	0.09	<0.03
pH			6.35	6.41	6.48	6.55
Phenols	mg/L	0.001	N/A	<0.001	<0.001	<0.001
Sulphate	mg/L	1	<1	<1	1	<1
Total Dissolved Solids (COND - CALC)	mg/L	1	23	29	34	41
Total Kjeldahl Nitrogen	mg/L	0.1	0.27	<0.10	<0.10	0.17
Total Suspended Solids	mg/L	2	12	430	508	3
Turbidity	NTU	0.1	1.1	> 100	> 100	5
HCO ₃ as CaCO ₃	mg/L	1	12	18	25	28
Calcium	mg/L	1	1	2	3	3
Magnesium	mg/L	1	<1	2	2	2
Potassium	mg/L	1	<1	<1	<1	<1
Sodium	mg/L	2	3	4	3	3
Aluminum	mg/L	0.01	<0.01	0.09	0.08	0.04
Antimony	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.01	0.02	<0.01	<0.01	0.02
Beryllium	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Boron	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	0.001	<0.001	<0.001
Cobalt	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Copper	mg/L	0.001	<0.001	0.003	<0.001	<0.001
Iron	mg/L	0.03	0.06	0.15	0.11	0.78
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001

Table 4.6-7: Results of analytical tests on surface water samples at Aurora (2011). MRL – minimum recordable limit (milligrams per liter = mg/L, micro Siemens per centimeter = uS/cm, Nephelometric Turbidity Units = NTU).

Parameter	Units	MRL	ASP-01	ASP-02	ASP-03	ASP-04
Manganese	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Nickel	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Selenium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Silicon	mg/L	0.1	6.6	8.1	7.8	10
Silver	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Strontium	mg/L	0.001	0.009	0.007	0.01	0.018
Thallium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	0.001	<0.001	0.005	0.001	<0.001
Zinc	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Oil & Grease- Mineral	mg/L	1	<1	<1	<1	<1
Oil & Grease- Non-mineral	mg/L	1	<1	<1	<1	<1
Oil & Grease- Total	mg/L	1	<1	<1	<1	<1

Table 4.6-8: Results of analytical tests on sediment samples at Aurora (2011). MRL - minimum recordable limit (%= percent, micrograms per gram = µg/g)

Parameter	Units	MRL	ASP-01	ASP-02	ASP-03	ASP-04
Loss on Ignition (@550C)	%	0.1	0.7	0.7	1.4	1.3
Total Organic Carbon	%	0.01	0.18	0.12	0.13	0.15
Calcium	µg/g	100	200	300	500	400
Magnesium	µg/g	100	<100	400	1400	200
Potassium	µg/g	100	<100	100	100	<100
Sodium	µg/g	100	<100	<100	<100	<100
Aluminum	µg/g	5	1140	7210	8240	4990
Antimony	µg/g	1	<1	<1	<1	<1
Arsenic	µg/g	1	<1	1	2	2
Barium	µg/g	1	8	34	23	19
Beryllium	µg/g	1	<1	<1	<1	<1
Cadmium	µg/g	0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	1	5	109	104	78
Cobalt	µg/g	1	1	10	14	7

Table 4.6-8: Results of analytical tests on sediment samples at Aurora (2011). MRL - minimum recordable limit (%= percent, micrograms per gram = µg/g)

Parameter	Units	MRL	ASP-01	ASP-02	ASP-03	ASP-04
Copper	µg/g	1	<1	10	25	16
Iron	µg/g	5	2850	25000	30000	23000
Lead	µg/g	1	<1	3	3	3
Manganese	µg/g	1	35	324	205	95
Mercury	µg/g	0.1	<0.1	<0.1	0.6	<0.1
Molybdenum	µg/g	1	<1	<1	<1	<1
Nickel	µg/g	1	2	22	25	9
Selenium	µg/g	1	<1	<1	<1	<1
Silver	µg/g	0.2	<0.2	<0.2	<0.2	<0.2
Strontium	µg/g	1	<1	1	1	2
Thallium	µg/g	1	<1	<1	<1	<1
Vanadium	µg/g	2	6	60	81	54
Zinc	µg/g	2	3	18	30	30

In 2006 and 2007, groundwater sampling of monitoring wells MW-1 through MW-5 was conducted on a quarterly basis to assess seasonal variations in groundwater quality. During each sampling event, the depth to groundwater was measured in each well prior to the start of well purging activities. Clean and dedicated bailers were used to purge and sample each well. As part of sampling, approximately one well volume was purged from each well due to limited well yields and slow groundwater recovery as a result of the relatively impervious geologic conditions. Unfiltered groundwater samples were collected in accordance with procedures outlined in the USEPA's *RCRA Ground-water Monitoring Technical Enforcement Guidance Document*. During the initial sampling period, no groundwater samples were collected from MW-3 and MW-4 since those wells were dry at the time of sampling.

Groundwater sampling results are provided in **Tables 4.6-9 through 4.6-12**. Potable water guideline values published by the World Health Organization (WHO) for various chemicals are also presented in the table for comparison purposes. Concentrations are presented in mg/L unless otherwise specified.

Table 4.6-9: Groundwater analytical results (milligrams per liter = mg/L, NA = not applicable), February 10, 2006

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Biochemical Oxygen Demand	mg/L	< 1	10	--	--	--	NA
Cyanide (free)	mg/L	< 0.025	< 0.025	--	--	< 0.25	NA
Cyanide (total)	mg/L	< 0.025	< 0.025	--	--	< 0.025	0.07
pH		6.22	5.48	--	--	7.01	NA

**Table 4.6-9: Groundwater analytical results (milligrams per liter = mg/L, NA = not applicable),
February 10, 2006**

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Total Suspended Solids	mg/L	41,600	73,700	--	--	19,200	NA
Arsenic	mg/L	< 0.01	< 0.01	--	--	< 0.01	0.01
Cadmium	mg/L	0.005	0.008	--	--	< 0.001	0.003
Chromium	mg/L	0.025	0.048	--	--	0.012	0.05
Copper	mg/L	0.27	0.21	--	--	0.07	2
Hexavalent Chromium	mg/L	< 0.05	< 0.05	--	--	< 0.05	NA
Iron, Total	mg/L	19.9	245	--	--	6.7	NA
Lead	mg/L	0.07	0.06	--	--	0.02	0.01
Mercury	mg/L	< 0.0001	< 0.0001	--	--	< 0.0001	0.006
Nickel	mg/L	0.14	0.26	--	--	< 0.05	0.07
Zinc	mg/L	2.98	3.93	--	--	0.3	NA
Oil and Grease, Mineral	mg/L	< 1.0	< 1.0	--	--	6	NA
Oil and Grease, Non-Mineral	mg/L	< 4.0	< 4.0	--	--	4	NA
Oil and Grease, Total	mg/L	< 5.0	< 5.0	--	--	10	NA

**Table 4.6-10: Groundwater analytical results (milligrams per liter = mg/L, NA = not applicable),
July 6, 2006**

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Biochemical Oxygen Demand	mg/L	< 1	10	<1	1	46	NA
Cyanide (free)	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	NA
Cyanide (total)	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	0.07
pH		6.75	5.76	4.64	5.48	6.41	NA
Total Suspended Solids	mg/L	6432	7870	6930	15100	6110	NA
Arsenic	mg/L	< 0.001	< 0.001	<0.001	<0.001	<0.001	0.01
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.003
Chromium	mg/L	0.012	0.004	0.005	0.006	0.002	0.05
Copper	mg/L	0.29	0.27	0.007	0.004	<0.001	2
Hexavalent Chromium	mg/L	< 0.05	< 0.05	<0.05	<0.05	<0.05	NA
Iron, Total	mg/L	21.8	262	0.73	0.86	1.45	NA
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Mercury	mg/L	< 0.0001	< 0.0001	<0.0001	<0.0001	<0.0001	0.006
Nickel	mg/L	0.18	0.32	0.005	<0.005	<0.005	0.07
Zinc	mg/L	3.03	3.28	0.02	0.01	<0.01	NA
Oil and Grease, Mineral	mg/L	< 1.0	< 1.0	<1	<1	3	NA
Oil and Grease, Non-Mineral	mg/L	< 4.0	< 4.0	<4	<4	<4	NA

Table 4.6-10: Groundwater analytical results (milligrams per liter = mg/L, NA = not applicable), July 6, 2006

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Oil and Grease, Total	mg/L	< 5.0	< 5.0	<5	<5	<5	NA

Table 4.6-11: Groundwater analytical results (milligrams per liter = mg/L, NA = Not applicable), October 12, 2006

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Biochemical Oxygen Demand	mg/L	<1	<1	<1	<1	5	NA
Cyanide (free)	mg/L	0.015	0.007	0.19	0.385	0.014	NA
Cyanide (total)	mg/L	--	--	--	--	--	0.07
pH		5.85	6.23	5.56	5.35	6.43	NA
Total Suspended Solids	mg/L	633	10	8320	27500	2700	NA
Arsenic	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Cadmium	mg/L	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	0.003
Chromium	mg/L	0.002	0.002	0.008	0.008	0.001	0.05
Copper	mg/L	0.001	0.002	0.008	0.007	0.002	2
Hexavalent Chromium	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	NA
Iron, Total	mg/L	0.27	0.54	1.36	0.79	1.49	NA
Lead	mg/L	<0.001	<0.001	0.001	<0.001	<0.001	0.01
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.006
Nickel	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	0.07
Zinc	mg/L	0.01	<0.01	0.03	0.02	<0.01	NA
Oil and Grease, Mineral	mg/L	3	--	<1	<1	<1	NA
Oil and Grease, Non-Mineral	mg/L	4	--	<4	<4	4	NA
Oil and Grease, Total	mg/L	7	--	<5	<5	<5	NA

Table 4.6-12: Groundwater analytical results (milligrams per liter = mg/L, NA = not applicable), March 4, 2007

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Biochemical Oxygen Demand	mg/L	2	<1	<1	<1	7	NA
Cyanide (free)	mg/L	<0.25	<0.25	<0.5	<0.5	<0.25	NA
Cyanide (total)	mg/L	<0.25	<0.25	<0.5	<0.5	<0.25	0.07
pH		7.31	7.06	6.15	6.58	6.87	NA
Total Suspended Solids	mg/L	19	1690	8330	8670	16300	NA
Arsenic	mg/L	<0.001	<0.001	0.001	<0.001	<0.001	0.01

Table 4.6-12: Groundwater analytical results (milligrams per liter = mg/L, NA = not applicable), March 4, 2007							
Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Cadmium	mg/L	0.0004	0.0002	<0.0001	<0.0001	<0.0001	0.003
Chromium	mg/L	0.003	0.004	0.007	0.003	0.002	0.05
Copper	mg/L	0.005	0.006	0.011	0.005	0.003	2
Hexavalent Chromium	mg/L	<0.05	<0.05	<0.05	<0.05	0.06	NA
Iron, Total	mg/L	0.34	3.40	0.88	1.52	0.26	NA
Lead	mg/L	<0.001	0.001	<0.001	<0.001	<0.001	0.01
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.006
Nickel	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	0.07
Zinc	mg/L	0.02	0.02	<0.01	<0.01	<0.01	NA
Oil and Grease, Mineral	mg/L	<1	<1	<1	--	<1	NA
Oil and Grease, Non-Mineral	mg/L	<4	<4	<4	--	4	NA
Oil and Grease, Total	mg/L	<5	<5	<5	--	<5	NA

As shown in **Tables 4.6-9** through **4.6-12**, several metals (i.e., cadmium, lead, and nickel) were detected during the first two sampling rounds at concentrations above the WHO guideline values for potable water quality. The majority of these exceedances occurred in monitoring wells MW-1 and MW-2.

In 2009, additional groundwater sampling was conducted to assess baseline groundwater quality conditions at locations in the vicinity of the proposed mining operations. Specifically, groundwater samples were collected from the following monitoring well locations:

- GW1—located in the vicinity of the proposed river dykes (N751555, E196582);
- GW2—located along the western end of the proposed TMA (N747672, E193108); and
- GW3—located in the vicinity of the proposed Water Management Area (N750856, E194646).

Additional details regarding these groundwater sampling locations are provided below.

River Dyke –Two dykes are currently proposed along the southern bank of the Cuyuni River to protect the open surface mine pits from extreme floods. Six geotechnical groundwater monitoring wells were installed along the footprint of the proposed dyke areas. Groundwater sampling was conducted from the well (GW1) located near the center of the entire length of the proposed dykes. Topography at this location is generally flat. The average groundwater level was measured at about 3 m below ground surface. The type of soil encountered during drilling of this well was predominantly silty clay.

TMA –This area has been allocated to contain the mine life tailings; the design has recently been consolidated and moved to an area due south of the open pits, adjacent to the process plan. However, data from the earlier studies are still useful to the interpretation of the

groundwater regime. Six geotechnical monitoring wells were installed along the footprint of the original configuration of the proposed tailings dam. Groundwater sampling was conducted from the well (GW2) with the lowest elevation. The average groundwater level was measured at about 3 m below ground surface. A creek is located approximately 60 m from this well and bedrock was encountered at a depth of less than 1 m below ground surface. The topography of both the current and former TMA locations is very hilly.

MWP - This area was originally designated to serve as the central water management facility for the entire site, and was located to the west of the open pits. This pond area has been replaced by the MWP (due south of the open pit area/due north of the new TMA) and the FWP due east of the new TMA. However, data from the earlier studies are still deemed useful to the interpretation of the groundwater regime in the area of the Project. Six geotechnical groundwater monitoring wells were installed along the footprint of the proposed perimeter dam of the original MWP. Groundwater sampling was conducted at the well (GW3) with the lowest elevation. The average groundwater level was measured at about 1 m below ground surface. A swampy area is located about 50 m from this monitoring well. The type of soil encountered during drilling of this well was predominantly a sandy silty clay. Topography in this area was generally flat.

The groundwater sampling results are provided in **Table 4.6-13**. Guideline values published by WHO for various chemicals are also presented in the table for comparison purposes.

Table 4.6-13: 2009 groundwater analytical results (milligrams per liter = mg/L, micro Siemens per centimeter = uS/cm, Nephelometric Turbidity Units = NTU)					
Parameter	Units	GW1	GW2	GW3	WHO Guideline Value
Alkalinity as CaCO ₃	mg/L	25	238	1,491	NA
Chloride	mg/L	12	6	16	NA
Conductivity	uS/cm	88	378	6,060	NA
Cyanide (free)	mg/L	<0.10	<0.10	<0.10	NA
Cyanide (total)	mg/L	<0.10	<0.10	<0.10	0.07
Fluoride	mg/L	<0.10	0.17	<0.10	1.5
N-NO ₂ (Nitrite)	mg/L	<0.10	<2.5	<0.10	3
N-NO ₃ (Nitrate)	mg/L	<0.10	<2.5	<0.10	50
pH		6.20	8.50	12.4	NA
Phenols	mg/L	<0.001	<0.001	0.014	NA
Sulphate	mg/L	4	4	8	NA
Total Dissolved Solids (COND - CALC)	mg/L	57	246	3,940	NA
Total Kjeldahl Nitrogen	mg/L	0.13	1.67	8.17	NA
Total Phosphorus	mg/L	0.02	0.02	0.05	NA
Total Suspended Solids	mg/L	21,000	832	841	NA
Turbidity	NTU	>100	>100	>100	NA

Table 4.6-13: 2009 groundwater analytical results (milligrams per liter = mg/L, micro Siemens per centimeter = uS/cm, Nephelometric Turbidity Units = NTU)

Parameter	Units	GW1	GW2	GW3	WHO Guideline Value
HCO ₃ as CaCO ₃	mg/L	25	231	<5	NA
Calcium	mg/L	3	77	535	NA
Magnesium	mg/L	1	3	<1	NA
Potassium	mg/L	<1	3	13	NA
Sodium	mg/L	9	12	51	NA
Aluminum	mg/L	3.6	5.0	0.76	NA
Antimony	mg/L	<0.0001	0.0003	0.0005	0.02
Arsenic	mg/L	<0.001	<0.001	<0.001	0.01
Barium	mg/L	0.89	1.4	3.9	0.7
Beryllium	mg/L	<0.001	<0.001	<0.001	NA
Boron	mg/L	0.01	0.01	0.01	0.5
Cadmium	mg/L	0.0003	0.0003	<0.0001	0.003
Chromium	mg/L	0.005	0.008	0.002	0.05
Cobalt	mg/L	0.103	0.0114	0.0028	NA
Copper	mg/L	0.051	0.071	0.008	2
Iron	mg/L	4.65	3.62	<0.03	NA
Lead	mg/L	0.032	0.005	<0.001	0.01
Manganese	mg/L	4.16	0.52	<0.01	0.4
Mercury	mg/L	<0.0001	<0.0001	<0.0001	0.006
Molybdenum	mg/L	<0.005	0.022	0.009	0.07
Nickel	mg/L	0.021	0.015	0.083	0.07
Selenium	mg/L	0.008	<0.001	0.003	0.01
Silicon	mg/L	14	20	0.7	NA
Silver	mg/L	<0.0001	0.0005	<0.0001	NA
Strontium	mg/L	0.051	0.139	4.17	NA
Thallium	mg/L	0.0001	<0.0001	<0.0001	NA
Titanium	mg/L	<0.01	0.03	<0.01	NA
Vanadium	mg/L	0.037	0.021	0.003	NA
Zinc	mg/L	0.16	0.09	<0.01	NA
Oil & Grease - Mineral	mg/L	<1	27	5	NA
Oil & Grease - Non-mineral	mg/L	1	57	14	NA
Oil & Grease - Total	mg/L	1	84	19	NA

As shown in **Table 4.6-13** above, several metals (barium, lead, manganese, and nickel) were detected in groundwater samples at concentrations above WHO guideline values for drinking-water quality. Oil and grease was detected at elevated levels in groundwater samples GW2 and GW3; however, the sources of these contaminants were unknown. Groundwater collected from monitoring well GW3 also had an extremely elevated pH of 12.4, which could be attributed to the presence of residual drilling fluids or cement grout in the well.

In July 2011, a well installation program was initiated at Aurora to fill the data gaps required to ensure a proper definition of the regional groundwater flow regime at the site. Four monitoring wells were installed in bedrock and a single monitoring well in saprolite.

Groundwater samples were recovered from selected wells screened in the saprolite zone to develop data on groundwater quality. At Aurora, these samples were considered to be representative of groundwater quality at the site since there is an upward gradient from the bedrock into the saprolite at shallow depths. The groundwater samples were recovered in accordance with the *USEPA RCRA Groundwater Monitoring Technical Enforcement Guidelines* (USEPA, 1986). All groundwater samples were tested for parameters mandated by the Guyana Environmental Protection Agency (EPA) for mine site operations, and the IFC: pH, total dissolved solids (TDS), TSS, turbidity, conductivity, organic compounds (phenol and oil and grease), major anions (Ca, Mg, Na, K), nutrients (total Kjeldahl nitrogen [TKN], total ammonia, phosphate, nitrate + nitrite), trace metals (Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Sb, Zn).

At Aurora, none of the parameters measured in the 2011 groundwater samples exceeded IFC (2007) requirements (see **Table 4.6-14**).

Table 4.6-14: Results of analytical tests on 2011 groundwater samples at Aurora (milligrams per liter = mg/L, micro Siemens per centimeter = uS/cm, Nephelometric Turbidity Units = NTU, minimum recordable limit = MRL)								
			Well ID					
Parameter	Units	MRL	BH09-RK-RMP-01A	BH09-08A	BH09-11-SW	BH09-29	BH09-21	BH09-25
Alkalinity as CaCO ₃	mg/L	5	79	121	144	168	63	153
Bromide	mg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Chloride	mg/L	1	6	10	7	7	11	10
Conductivity	uS/cm	5	154	345	259	336	147	313
Fluoride	mg/L	0.1	0.14	0.16	<0.10	<0.10	<0.10	<0.10
N-NH ₃ (Ammonia)	mg/L	0.02	0.21	0.33	11.9	<0.02	5.63	1.27
N-NO ₂ (Nitrite)	mg/L	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
N-NO ₃ (Nitrate)	mg/L	0.1	<0.10	0.27	<0.10	<0.10	<0.10	<0.10
O-PO ₄ (Ortho-Phosphate)	mg/L	0.03	0.03	<0.03	0.06	<0.03	<0.03	<0.03
pH			6.82	7.23	7.23	7.17	6.62	7.45
Phenols	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Sulphate	mg/L	1	<1	39	4	7	3	6
Total Dissolved Solids (COND - C ALC)	mg/L	1	100	224	168	218	96	203
Total Kjeldahl Nitrogen	mg/L	0.1	0.96	1.32	52.6	<0.10	15.9	2.66
Total Suspended Solids	mg/L	2	50	56	123	255	220	417

Table 4.6-14: Results of analytical tests on 2011 groundwater samples at Aurora (milligrams per liter = mg/L, micro Siemens per centimeter = uS/cm, Nephelometric Turbidity Units = NTU, minimum recordable limit = MRL)

Parameter	Units	MRL	Well ID					
			BH09-RK-RMP-01A	BH09-08A	BH09-11-SW	BH09-29	BH09-21	BH09-25
Turbidity	NTU	0.1	16.1	1.6	11.8	3.1	15.8	13.4
HCO ₃ as CaCO ₃	mg/L	1	79	121	144	168	63	153
Calcium	mg/L	1	15	19	8	69	11	49
Magnesium	mg/L	1	6	7	3	<1	2	<1
Potassium	mg/L	1	2	1	2	<1	<1	9
Sodium	mg/L	2	9	48	32	4	13	7
Aluminum	mg/L	0.01	0.12	0.01	0.08	<0.01	0.12	0.05
Antimony	mg/L	0.0005	<0.0005	0.0009	<0.0005	<0.0005	<0.0005	0.0005
Arsenic	mg/L	0.001	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.01	0.09	0.14	0.13	0.04	0.07	0.26
Beryllium	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Boron	mg/L	0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

4.7 Geology

4.7.1 Structural Geology

The Project is located in the Archean-Proterozoic Guiana Shield in northeast South America. The Guiana Shield is a palaeo-Proterozoic granite-greenstone terrane and is considered to be the extension of the West-African palaeo-Proterozoic Birimian Supergroup terrane. The rocks of the Guiana Shield are in excess of two billion years old.

The Guiana Shield is largely composed of the Barama-Mazaruni Supergroup, a metasedimentary/greenstone terrane intercalated with Archean-Proterozoic gneisses that are intruded by Trans-Amazonian granites, as well as mafic and ultramafic rocks (McConnell and Williams, 1969). The Barama Group consists of pelitic metasedimentary and metavolcanic rocks. The Mazaruni Group conformably overlies the Barama Group, which also consists of metasedimentary and metavolcanic rocks. The Mazaruni Group is subdivided into the Cuyuni Formation and the Haimaraka Formation. The Cuyuni Formation consists of pebbly sandstone and intraformational conglomerate, intercalated with felsic to mafic volcanic rock. The Haimaraka Formation conformably overlies the Cuyuni Formation and consists of a thick sequence of mudstone, pelite, and graywacke; significant amounts of volcanic rock are absent from this unit (McConnell and Williams, 1969). The Barama-Mazaruni Supergroup formed within a geosynclinal basin locally bordered by an Archean continental foreland. The Trans-Amazonian Orogeny, approximately 2 billion years ago, resulted in block faulting, crustal shortening, folding, metamorphism and anatexis of the Barama-Mazaruni Supergroup (Hurley et al., 1967).

The regional metamorphic grade of the Barama-Mazaruni Supergroup is generally lower to middle greenschist facies. Near the contact of some of the larger granitic complexes, the Barama-Mazaruni Supergroup is metamorphosed to upper greenschist to amphibolite facies.

Syn- to late-Tectonic calc-alkaline to intermediate intrusive rocks, collectively known as the Trans- Amazonian Granitoids (Voicu et al., 1999), were emplaced during the Trans-Amazonian Orogeny, between 2.25 and 1.96 billion years ago (Gibbs and Barron, 1993). They range in composition from granite to granodiorite, diorite, and adamellite. Intrusive rocks proximal to the Project area include the Proterozoic-age Iroma-Ranka, Aurora, and Katruni medium-grained granodiorite and diorite intrusions, and late-stage basic sills and dykes.

The area is affected by a series of 1-m to 50-m-wide interconnected shear zones. The shear zones situated between the Rory's Knoll and Mad Kiss area strike northwest (between 290° and 305°) and dip steeply to the northeast (between 70° and 85°). In the Aleck Hill area, the two main shear zones strike to the southeast (approximately 155°) and dip to the southwest steeply (80°). The shear zones are characterized by a strong penetrative fabric locally forming schists in regions affected by the highest strain. Shear zones were modeled as litho-tectonic units and do not take into account the nature of the protolith. For instance, muscovite schists are probably derived from a mafic rock, not necessarily a felsic rock as often recorded in drill logs.

4.7.2 Geomorphology and Soils

As noted above, the Guiana Shield rocks are in excess of two billion years of age and can be described as *a land of old rock, poor soils, much water, extensive forest and few people* (Hammond, 2005). This is an area created primarily through erosion of ancient crystalline rocks with later episodes of marine transgression and deposits of marine and alluvial sediments. The Aurora site and the lower Cuyuni River basin are located in the Atlantic Coastal Shelf region of Guyana. Hammond (2005) describes three units within this region: the Recent Coastal plains, (-10–10 masl), the Tertiary Sandy Plains (10–50 masl), and the Pre-Cambrian Rolling Hills (50–300 masl) (Hammond, 2005). The Aurora site (elevation 80 masl) and vicinity (the highest hill in the Aurora concession is approximately 200 masl) are located in the Pre-Cambrian Rolling Hills, an undulating to hilly topography with a level floodplain along the Cuyuni River. Buckhall on the Essequibo River, only 10 masl, falls into the Recent Coastal Plains unit.

The native soils of the proposed mine site, along the access road, and at the Buckhall Port area consist of residual material derived from weathered acidic crystalline rocks (i.e., granite, schist, dolerite, granodiorite, and phyllite), alluvial sediments derived from stratified and unconsolidated deposits of sand, silts, and clays. In the upland areas, the soils consist of deep, well-drained, yellow and reddish-brown sandy clay loams and gravelly clays. In the riverine and alluvial fan areas, the soils are also deep but range from poorly- to excessively well-drained brown to white clay loams and sands (Braun and Derting, 1964). The soil types on the proposed Project site include seven soil map units (see **Figure 4.7-1**). **Table 4.7-1** summarizes the major characteristics of the soil types.

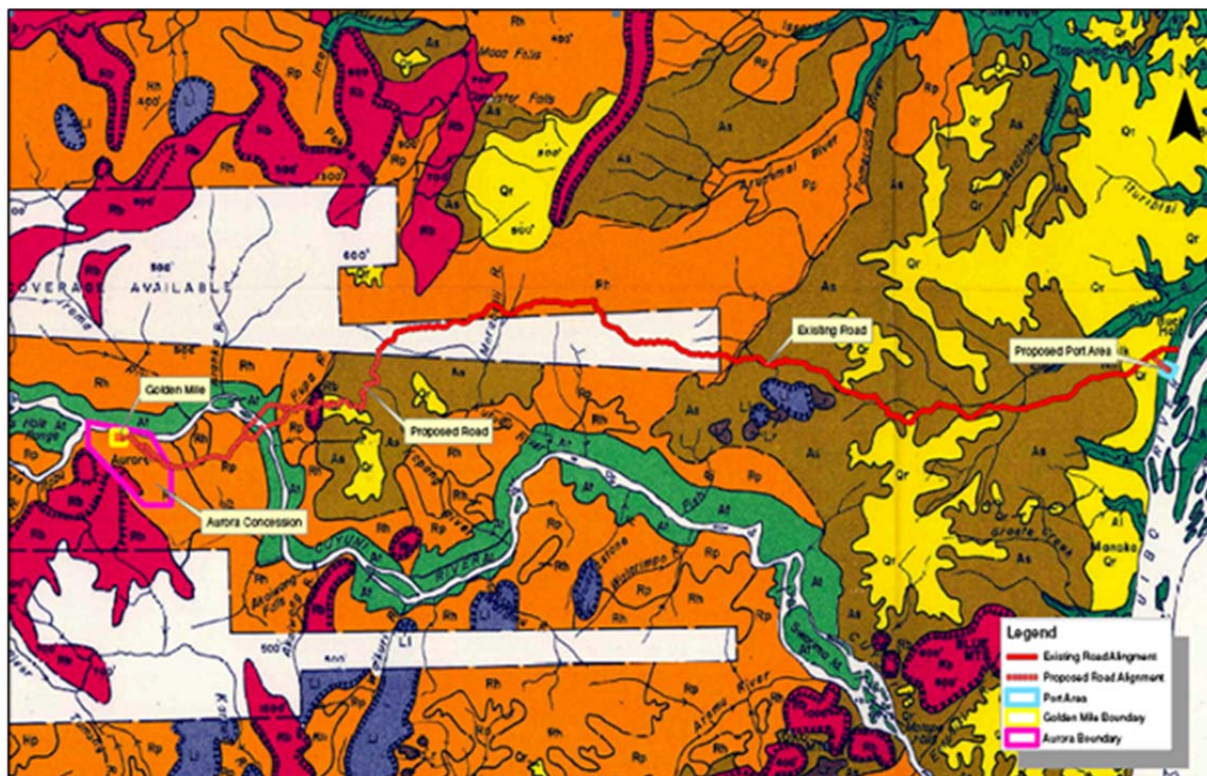


Figure 4.7-1: Soil Types within the Aurora Mine Area of Influence (See Table 4.7-1 below for description of soil types). Source: Soils map from Braun and Dertin (1964).

Table 4.7-1: Major characteristics of soil types found on the project site.

Soil Map Unit	Soil Association Characteristics	Geomorphology/Landform	Parent Material	Land Capability Classification*
Mine (Aurora Concession)				
Rh	Deep, dominantly well drained, yellow and brown, sandy clay loam, clay, and gravelly clay-soils (red-yellow soils). Shallow, excessively drained, sandy loam and silt loam soils with occasional gravel.	Hilly to steep residual uplands.	Deeply, weathered, residual, acidic crystalline rocks, such as granite, schist, phyllite, and granodiorite.	III
Rb	Deep, well drained, brown, and red gravelly clay and clay soils (reddish-brown lateritic soils).	Step to hilly, hills and mountains.	Deeply weathered, residual, basic rocks (dolerite and amphibolite).	III

Table 4.7-1: Major characteristics of soil types found on the project site.

Soil Map Unit	Soil Association Characteristics	Geomorphology/ Landform	Parent Material	Land Capability Classification*
Access Road				
Rh	Deep, dominantly well drained, yellow and brown, sandy clay loam, clay, and gravelly clay-soils (red-yellow soils). Shallow, excessively drained, sandy loam and silt loam soils with occasional gravel.	Hilly to steep residual uplands.	Deeply weathered, residual, acidic crystalline rocks, such as granite, schist, phyllite, and granodiorite.	III
Rp	Deep, dominantly well drained, yellow and brown, sandy clay loam, clay and gravelly clay soils (red-yellow soils). Poorly drained, silty and clayey soils (low-humic gleyed soils).	Rolling pedimentry and residual uplands.	Unconsolidated pedimentary and alluvial deposits and residual materials derived from deeply weathered acid crystalline rocks (granite, schist, and phyllite).	I – II
At	Association of deep, dominantly poorly and moderately well drained, grey and brown silty and sandy soils. Excessively drained white sand and well drained sandy clay loam.	Level to gently sloping river alluvium and terrace.	Stratified, unconsolidated, recent and subrecent deposits of sand, silt, and clay.	I – II
As	Association of deep, dominantly well drained, yellow and brown sandy clay loam and clay soils (red-yellow soils). Excessively drained brown and white sands, and shallow sandy loam soils.	Sloping to hilly dissected white sand plateau with crystalline exposures.	Stratified, unconsolidated, sandy deposits and residual acidic materials.	I – II
Qr	Deep, excessively or poorly drained white sand soils.	Gently sloping to sloping white sand plateau.	Stratified, unconsolidated, white quartz sand deposits.	IV
Wharf / Dock				
Qr	Deep, excessively or poorly drained white sand soils.	Gently sloping to sloping white sand plateau.	Stratified, unconsolidated, white quartz sand deposits.	IV
Al	Association of deep, grey and brown, poorly drained, clayey, silty and sandy soils (low-humic gleyed soils).	Nearly level to level river alluvium.	Stratified, unconsolidated, recent alluvial deposits of silt, clay, and sand.	I – II

Source: Environmental Resource Management, Inc. 2009 after Braun and Derting, 1964.

4.7.3 Acid Rock Drainage and Metal Leaching Studies

4.7.3.1 Initial Studies

SGS Mineral Services (SGS) was contracted by AMEC in 2009 to complete environmental and geotechnical characterization of cyanide destruct (CND) tailings from the Project. The purpose of the environmental test program, entitled “Environmental and Geotechnical Characterization of Guyana Goldfields Mine Tailings,” was to assess the geochemical, acid rock drainage (ARD) potential and geotechnical properties associated with the tailings materials. The report entitled “An Investigation into Geochemical and Geotechnical Characterization of Guyana Goldfields Mine Tailings” (SGS, 2010) was provided to AMEC to summarize results of the environmental and geotechnical testwork completed on the CND tailings from the Guyana Goldfield project. Interpretive analysis was not within the scope of SGS’s environmental test program, and as such, the report presents only analytical results and test reports; full text is provided for reference in **Appendix 9A**.

4.7.3.2 Static Test Results

Subsequent to the SGS report discussed above, Klohn Crippen Berger was contracted to perform further studies and provide interpretation of the results. In 2010, they collected and analyzed a total of 348 samples spanning the main lithologies/alterations identified. These lithologies include chlorite schist, diorite, felsic tuff, metavolcanic, quartz vein, saprolite, sericite schist, tonalite, and volcanic. The results of the memorandum from Klohn Crippen Berger to GGI entitled “Aurora Project – Static ARD/ML Interpretation” and dated 11 February, 2011, are included in **Appendix 9A** and are summarized as follows:

- solid-phase metal concentrations in excess of three times crustal abundance considered anomalous include those for Ag, As, Co, Cr, Cu, Ni and Se;
- total sulphide concentrations range from 0.01 to 2.9 wt. %;
- sulphate-sulphur concentrations range from 0.01 to 0.30 wt. %;
- sulphide-sulphur concentrations range from 0.01 to 2.1 wt. %;
- paste pH values range from 5.3 to 10.4 and indicate the majority of samples are not currently generating acidity;
- the Modified Sobek-Neutralization Potential (MS-NP) ranged from -3.5 to 288 kilograms (kg) CaCO_3 /tonne and is considered relatively high. The exception is for the saprolite samples that have been extensively leached and provide little acidity buffering;
- the carbonate NP (Inorg-CaNP) is also considered relatively high and ranges 0.23 to 478 kg CaCO_3 /tonne and is often higher than MS-NP indicating the presence of net-neutral ferroan or manganese carbonates that do not provide effective acidity buffering.
- MS-NP is used in materials classification as an appropriate conservative approach at this point in time.
- materials classification for all lithologies/alteration types is Not-Potentially Acid Generating (N-PAG) with a small proportion of saprolite and diorite samples plotting as Acid Generating (AG) and Potentially Acid Generating (PAG);

- Shake Flask Extractions (SFE) pH values are generally alkaline and ranged from pH 5.1 to 10.1. Testing showed relatively low release of soluble elements and are primarily the major cations; and
- Net Acid Generating (NAG) analyses confirm the N-PAG classification developed by the Acid-base Accounting (ABA) calculations. End member NAG pH values range from 3.8 to 11.6 and are not correlated to the initial sulphide-sulphur content. However, sulphate releases are and indicate total sulphide-sulphur oxidation acidity release is adequately buffered by available NP. The exception is one saprolite sample.

Samples were selected for humidity cell testing based on the median and 95th percentile sulphide-sulphur concentrations for all lithologies/alteration types. Additional characterization includes X-Ray Diffraction analyses with Rietveld refinement, particle size analyses, and supplemental SFE and NAG testing.

4.7.3.3 Kinetic Test Results

Based on the findings of the initial static testing, Klohn Crippen Berger constructed and operated 18 humidity cells between December 21, 2011, and June, 13, 2012, based on the MEND procedure. The humidity cells samples were also submitted for X-ray Diffraction with Rietveld Refinement. The results of the 25 weeks (cycles) of the laboratory humidity cell tests are provided in the report entitled “Acid Rock Drainage and Metal Leaching Characterization - Kinetic Test Results DRAFT Report” dated July 7, 2012. This report is included in **Appendix 9A** and is summarized in the following paragraphs.

The results of the kinetic humidity cell testing indicate a near-neutral to slightly alkaline pH leachate, indicating the abundance of carbonate buffering potential of waste rock materials with a low sulphide content. The single exception is the base case Volcanic/Volcanic Sediment humidity cell, which produced a slightly acidic pH during the entire 25-week test period.

The alkalinity production rates were high and the acidity production rates were very low, often below the detection limit of the analytical methodology. This highlights the presence of significant amount of carbonate buffering confirmed by the X-ray Diffraction results, identifying the common occurrence of calcite and dolomite and the rarity of sulphide minerals. The balance between the alkalinity and acidity production rates indicates that the Project waste rock material is generally not PAG and supports the ABA result previously reported.

Sulphate, calcium, and magnesium production rate trends indicate a first flush followed by a gradual decrease of production rates, then followed by stabilization. The sulphate production rate trend can be explained by an initial leaching of soluble sulphates previously stored in the samples followed by a low sulphide oxidation rate during the remainder of the test. On the other hand, calcium and magnesium production trends increased in several humidity cells after the first flush. The high calcium and magnesium production rates are associated primarily with the weathering and dissolution of calcite and dolomite.

The production rates of metals/metalloids and especially the parameters considered “abundant” in the geology, such as arsenic, cadmium, selenium, nickel, and copper, also show a first flush effect followed by a decrease of production rates, then stabilization. The production rates of

these elements are generally similar and low, with the exception of arsenic in the Metavolcanic (HC7) and nickel and zinc in the Volcanic/Volcanic Sediment (HC11). It is expected that the concentrations of near-neutral pH soluble elements will remain low or decrease further. The concentration of acid-soluble elements will also remain low, as it is expected that the pH will remain neutral or increase to an alkaline pH. However, the concentration of elements such as zinc may increase further if the pH becomes alkaline.

The comparison of the leachate pH and the concentrations of arsenic, cadmium, iron, mercury, chromium, and copper against the IFC EHS guidelines show that the concentrations are below the guidelines, except arsenic in the Metavolcanic (HC7) and the pH of the first flushes of the following humidity cells: HC3, HC5, HC7, HC10 and HC14. It is predicted that the leaching of these waste rock lithology and alteration types under site-specific conditions will have a negligible impact on the receiving environment. The humidity cell first flush concentrations are considered the highest possible leachable concentrations (worse case). However, the spatial variability of the geochemistry of several of the waste rock lithologies and alteration types, as indicated by the static results, may result in higher concentrations of leachate. This is illustrated by the behavior of the Metavolcanic and Volcanic/Volcanic Sediment materials used in HC7 and HC11, respectively.

As in the case of the leachate pH, the Acidic Volcanic (HC11) behaves different from other cells. The volcanic material in this cell produced the lowest alkalinity, calcium and magnesium productions rates and the highest nickel, iron and zinc loadings.

Finally, the kinetic humidity cell results support the ABA, SFE, and NAG test findings that the Project waste rock lithologies and alterations are overwhelmingly not PAG. Based on the calculated sulphide-sulphur and calcium and magnesium depletion rates and times, only the Diorite, Saprolite, Chlorite Schist, and Felsic Tuff lithology and alteration types are predicted to become acid generating in the future. The onset of acid rock drainage (ARD) for the Diorite and Saprolite is predicted to occur in 0.1 and 4.6 laboratory-based years, respectively. The Chlorite Schist and Felsic Tuff lithologies and alteration units are predicted to become acid generating in 62.5 and 183 laboratory-based years, respectively.

Given the low sulphide-sulphur and high calcite and dolomite content of these waste rock lithologies and alteration types, coupled with the majority (1 of 18 humidity cells) of lithologies and alteration types predicted to never become acid generating, no special waste management strategies were recommended, apart from recommending that the *Water Management Plan* developed for the Project provides for ongoing assessment of the geochemical variability of each lithology and alteration unit.

4.8 Biodiversity

4.8.1 Scope of the Biodiversity Assessment

The characterization of the biological environment considers biodiversity in a regional context that includes the Project AOI and the middle Cuyuni basin, which are within the Guianan Moist Forests ecoregion (GMFE), the latter being defined as the Moist Forest Zone of the coastal lowlands (Schipper et al., 2012), or Atlantic Coastal Shelf (Hammond, 2005). As noted in

Figure 4.7-1 above, below 500 masl, Guianan Moist Forest fauna are largely shared with other humid lowland ecoregions of the Amazon basin.

The overall AOI for the biodiversity baseline is presented in **Figures 4.1-1** and **4.1-2** above and incorporates a 500-m buffer from the maximum perimeter of the Aurora site mining operation and either side of the access road between the Aurora site and Buckhall. The Project also includes the the Tapir Crossing ferry and the road from Buckhall to Aurora, the greater portion of which is shared with Barama Company Limited.

4.8.2 General Characterization of the Region

The biodiversity of the Guiana Shield Region has been a focus of inventory efforts by the Smithsonian Institution's Biological Diversity of the Guiana Shield Program, resulting in recent checklists for vascular plants (Funk et al., 2007), fish (Vari & Ferraris, 2009), and terrestrial vertebrates (Hollowell & Reynolds, 2005). These data provide a valuable regional baseline on species richness. However, there has been little focused biodiversity data collection in the Cuyuni basin itself. Naturalist William Beebe produced a series of studies from his base near Bartica in the 1930s. Lynne Gillespie collected a series of plants along the Cuyuni River around the Aurora camp in 1997. The fish of the Venezuelan portion of the Cuyuni basin have been better studied by Machado-Allison and colleagues (Machado-Allison et al., 2000) and Sidlauskas and others surveyed the fish of the Guyana portion of the Cuyuni in 2011 (University of Toronto Scarborough, 2011; Sislauskas, 2011).

The ecosystems of the Cuyuni River basin are dominated by forests which are intermingled among aquatic environments in the form of rivers and numerous small, largely low gradient streams. Most of the bottomland forests along the rivers and in small stream valleys are seasonally flooded and support aquatic biota during the wet season. The valley slopes, hillslopes, and ridgetops support forests with species intolerant of, or at least not requiring, seasonal flooding. Portions of these ecosystems that have only been disturbed slightly by human activity and support a large diversity of widespread humid forest fauna typical of the Neotropics generally (such as jaguars and peccaries), with other species typical of the greater Amazonian (such as lowland tapirs and black caiman) or Guianan Shield regions (such as Guiana red howler monkeys and black curassows).

The forest-river systems of the Cuyuni basin are integrated through surface and groundwater hydrological processes, and the forests are important for the maintenance of hydrology and water quality. The natural surface waters of the region are generally considered "blackwaters," with low pH, high contents of tannins and humic organic acids from the breakdown of leaf litter, and low suspended solids, but in the Cuyuni basin, the natural condition has been altered by human impacts. ASM has been identified as the leading cause of deforestation in Guyana, responsible for 94% of deforestation (Guyana Forestry Commission, 2012). During the period 2010 to 2011, deforestation totaled 9,796 ha/yr, and the majority of this (96%) took place in state forests, primarily along the rivers—the primary means of egress—and along existing roads.

The biodiversity and environmental quality of the greater project area has been significantly and adversely affected by mining as well as logging. Despite the relatively remote location, the

Project area shows signs of environmental degradation and depletion of fauna, which has been well documented in studies such as (Duplaix, 2009) (see **Appendix 4A**) and (Sidlauskas, 2011). The Cuyuni River basin and much of Region 7 and adjacent areas have been historically affected by mining activities since at least the 1800s (Perkins, 1893). Gold and other mineral deposits of market value occur in alluvial sediments and in ore form. ASM activities had been and continue to be primarily surface alluvial mining along tributary creeks to the Cuyuni, but dredging of the river bed sediments is another popular method. This type of mining has led to a vast increase in turbidity and sedimentation in the river. The use of mercury in the amalgamation process and its release to the environment is another major environmental concern in Region 7. Studies of sediments in the Mazuruni and Essequibo suggest that that much of the mercury found in the alluvial deposits is related to anthropogenic sources and have increased in recent years (Miller, et al., 2003).

There has been some research on mining impacts in the Venezuelan portion of the Cuyuni basin (Nico & Taphorn, 1994; García-Sánchez et al., 2008) as well as general studies in Guyana by WWF (Lowe, 2008). The fish abundance and diversity of the upper Cuyuni River basin in Venezuela has been adversely affected by historical artisanal mining (albeit some of which is considered to be large scale) due largely to impacts from accelerated sedimentation and increased turbidity. The Cuyuni River has experienced degradation of water quality since the 1980s from the discharge of sediment- and contaminant-laden waters from ASM into its tributaries (see **Image 4-1** above). The river has become increasingly turbid and mercury has accumulated in the aquatic ecosystem.

Both the Cuyuni and Mazaruni basins have been historically affected by ASM activities, which have resulted in contamination of rivers with mercury and increased turbidity. There has been some research on mining impacts in the Venezuelan portion of the Cuyuni basin (Nico & Taphorn, 1994; García-Sánchez et al., 2008) as well as general studies in Guyana by WWF (Lowe, 2008). The fish abundance and diversity of the upper Cuyuni River basin in Venezuela has also been adversely affected by historical ASM due largely to impacts from accelerated sedimentation and increased turbidity. The Cuyuni River has experienced degradation of water quality since the 1980s from the discharge of sediment and contaminant-laden waters from ASM into its tributaries (**Image 4.8-1**). The river has become increasingly turbid and there is evidence that mercury has accumulated in the aquatic ecosystem based in the upper Cuyuni in Venezuela (Nico and Taphorn, 1994).

Specifically within the Project AOI, biodiversity has also been affected to some degree by hunting, logging, and mining activities for over two centuries. In all likelihood, the Cuyuni River has served as a transportation corridor since the arrival of the first indigenous peoples to the basin. Construction of the Barama Road has led to increased human activity to the north of the Cuyuni River and to the west of the Essequibo River. The Aurora site was first developed as an ASM site in the 1930s and has been impacted by mining activities ever since, as has the surrounding area. As previously noted, large fauna common in pristine habitats along similar types of rivers in the Guianas are absent or rare in the Project area because of the cumulative impacts of hunting, degradation of river quality by ASM activity, and disturbance by outboard motorboats.

4.8.3 Biological Sampling of the Study Area

The Project has a long history of field data collection for the purpose of characterizing the existing environmental conditions at the Aurora site and vicinity. Formal studies began in 2006 and continued through 2012.

Biological sampling or biodiversity surveys associated with the potential development of mining operations in the Aurora concession began in 2006 and are summarized in **Table 4.2-1** above. The initial biological surveys of the Aurora concession were performed in 2006 and 2007 by Guyanese biologists and the WWF. To upgrade the existing baseline information, a biodiversity assessment was conducted for the Project AOI in 2009 by the consulting firm ERM with a focus on determination of presence or absence of critical habitat as defined by IFC PS 6 (IFC, 2012b). The assessment used various data sources and methodologies including satellite imagery, literature surveys, field sampling and capture, direct observation, and where appropriate, interviews. Data collection for the physical environment focused on surface water hydrology, geology, topography, soil type, climate and meteorology, ambient air quality, noise, and water quality, as discussed below. The biodiversity data collection focused on flora and fauna, endemic and threatened species, identification of potential sensitive habitats including wetlands, species of socioeconomic or cultural importance, migratory and congregational species, and protected areas in the region.

The 2009 field inventory of biological resources for the Aurora mine site and vicinity was performed from April 28 through May 5, 2009. During this period biological features at the mine site and its environs were characterized. Both diurnal and nocturnal surveys were conducted. The vegetation of the Golden Square Mile, the TMA and MWP (as identified at the time of the survey), and the Julian Ross Itabu areas were characterized by cataloging the dominant tree and shrub species. This included sample collection of certain plants, identification and recording. Fish were sampled by netting and hook and line. Amphibians and reptiles were sampled by VES and auditory surveys. Birds were sampled by point counts and mist netting. Mammals were documented by direct and indirect observation (e.g., tracks, scat, fur) supplemented by interviews with Guyanese experts on the biodiversity of the area.

A specialized survey for giant otters was completed along the Cuyuni River, including the Julian Ross Itabu Branch, and various tributaries from October 13 through 22, 2009, by international giant otter specialist Dr. Nicole Duplaix [see (Duplaix, 2009), the full text of which is included in **Appendix 4A**]. No otters or recent evidence for their presence was observed. Dr. Duplaix concluded that the habitat was not suitable given the high level of turbidity in the rivers (largely from ASM activity upstream of the study area), and that the two lone individual specimens sighted in multiple years of baseline field work were likely migrants passing through the area and not resident.

In 2011, two additional biological assessments at the Aurora concession were conducted by local ecological specialists under the supervision of ENVIRON. A wet season assessment was conducted between July and September 2011, and the dry season assessment was conducted from October to November 2011. The wet and dry season assessments were designed to 1) validate the previous findings of biological surveys conducted in 2009 at Aurora and 2) evaluate

the presence of critical habitat as defined by IFC PS 6 (IFC, 2012b). This standard defines critical habitats as areas having high biodiversity value, and may include the following:

- habitats of significant importance to critically endangered and/or endangered species;
- habitats of significant importance to endemic and/or restricted-range species;
- habitats of significant importance to globally significant concentrations of migratory species and/or congregatory species;
- regionally significant and/or highly threatened or unique ecosystems; and/or
- areas which are associated with key evolutionary processes.

As noted in Section 4.2-3 (Biological Sampling) and **Table 4.2-1**, field studies of the biodiversity of the Project vicinity began in 2006 and over 111 days of field surveys have been carried out. In 2011 under ENVIRON's guidance, six local biologists conducted the most recent studies—wet season (July-September) and dry season (September-October) biological assessments. Preliminary results from another independent field study conducted in 2011 also indicate a substantial depletion of fish species and abundance upstream and downstream from the Aurora site (Sidlauskas, 2011).

No biodiversity data were collected from the Buckhall area or along the length of the Barama portion of the access road route, as these areas have been subject to frequent disturbances associated with intrusive human activities and settlements for many years. It may be assumed that all areas within 10 km of the Cuyuni River have been significantly affected historically by human activities, including hunting and exploration by small-scale miners and loggers.

4.8.4 Regional and Biogeographic Settings

Within the Aurora Project AOI, biodiversity has been adversely impacted to by logging and mining activities throughout the 19th, 20th, and 21st centuries. The Cuyuni River has served as a transportation corridor likely since the arrival of the first indigenous peoples to the basin. Construction of the Barama Road has led to increased human activity to the north of the Cuyuni River and to the west of the Essequibo River (**Image 4.8-1**).



Image 4.8-1: The Barama Road and Associated Small-Scale Mining Activity to North of the Cuyuni River, March 2009 Source: Langstroth, 2009

The Aurora site was first developed as a mining project in the 1930s and has been affected by mining activities ever since. Large fauna that are otherwise common in pristine habitats along similar types of rivers in the Guianas are absent or rare in the project area, presumably due to hunting, degradation of river quality, and disturbance by outboard motorboats.

The Aurora concession is located in the coastal lowlands/Atlantic Coastal Shelf (Hammond, 2005) region of northwestern Guyana, some 150 km inland from the Atlantic coast of northern South America. This relatively low-lying area is considered to be part of the Guiana Shield region as defined by recent regional studies (e.g., Huber and Foster, 2003; Hollowell and Reynolds, 2005; Hammond, 2005); however, it is biogeographically distinct from the Guiana Shield Highland centers of endemism. Biogeographically, the lowlands of the Guianas are much more closely related to the forested lowlands of the Amazon Basin and are often included under broader definitions of Amazonia due to their overriding similarities, despite the presence of some regional endemism. In contrast, the highlands of the Guiana Shield, especially at elevations greater than 1,500 m, are important as a center of endemism for various groups of plants and animals.

The Essequibo River and the seasonally flooded Rupununi savannas of southwestern Guyana serve as biological corridors for aquatic biota that directly link the Amazon Basin and the watersheds north of the Guiana Shield. The Cuyuni River discharges into the lower Mazaruni River near the Essequibo, and thus is connected to Amazonian aquatic ecosystems via the Rupununi savannas.

The vertebrate faunal diversity of the Guianan Lowland forests is comprised largely of widespread species found across the humid lowland forests of the Amazon Basin and the Guianan Lowlands. Endemic Guianan vertebrate species are generally restricted to the highlands of the Guianan Shield, or to the savanna and dry forest ecosystems.

Based on analyses of large-scale forestry inventories, Ter Steege and Zondervan (2000) proposed five groupings of the Guianan forest:

1. Forests in the coastal plain (Venezuela-Guyana-Suriname-French Guiana)
2. Forests in the North West District of Guyana and adjacent lowland Venezuela
3. Forests on White Sands Formation (Guyana-Suriname-French Guiana)
4. Forests in the Pakaraima-Central Guiana Upland region (Guyana-Venezuela-Brazil)
5. Forests on the southern peneplain (Guyana-Suriname-French Guiana-Brazil)

The Cuyuni basin lies within the second division identified above (North West District of Guyana and lowland Venezuelan Guyana). The upland forests of northwestern Guyana and bordering Venezuela are found on soils developed on the ancient, Pre-Cambrian Guiana Shield, consisting of granites and greenstones, as well as on smaller areas covered by Plio-Pleistocene sediments. The upland forests are characterized by a high abundance of *Eschweilera sagotiana*, *Alexa imperatricis*, *Catostemma commune*, *Licania spp.* and *Protium decandrum*. Most of these species belong to genera of the 'Lowland Guianas Dominants' identified by Ter Steege and Zondervan (2000). Upland forests dominated by *Alexa*, *Eschweilera*, *Licania* and *Catostemma* continue far into Venezuela. Poor mono-dominant stands of *M. gonggrijpii* are likely found on the more clayey soils between the Cuyuni and Mazaruni, as well as in the eastern parts of Venezuelan Guyana. Extraction of plywood species (mainly *Catostemma*, *Alexa* and *Mouriri*) in the area has increased quite substantially in recent years.

IFC biodiversity guidelines require consideration of areas of recognized global, national, or local importance to biodiversity, such as legally protected areas, World Heritage sites, Ramsar sites, Important Bird Areas (IBAs), Key Biodiversity Areas, community reserves, and natural reserves, as well as ecoregional planning. There has been no formal ecoregional planning by the Guyana Ministry of Natural Resources and the Environment and/or by any partnering organizations (e.g., WWF, Conservation International [CI]). The Guyana Shield Conservation Priority-Setting Workshop was held in April 2002 under the cosponsorship of CI, the Guiana Shield Initiative of the Netherlands Committee for International Union for Conservation of Nature (IUCN) (GSI/NC-IUCN), the Caribbean Sub-regional Resource Facility of the United Nations Development Programme (UNDP), UNDP Suriname, and UNDP Guyana. One result of the workshop was a series of maps of biodiversity and conservation priority areas within the Guiana Shield region. Portions of four priority areas fall within the Cuyuni and Mazaruni basins (see **Table 4.8-1 and Figure 4.8-1**).

The Guyana Shield Initiative Priority Area No. 20 (Cuyuni) is located to the north of the Aurora concession and north of the Cuyuni River and traversed by the existing Barama Road. It is included for its importance for floristics, reptiles, and mammals; however, no specific information to substantiate this biogeographic distinctiveness is available in the GSI report. The other areas are remote from the Project AOI.

Table 4.8-1: Description of Guiana Shield Initiative (GSI) priority areas in the Cuyuni and Mazaruni River basins

Area Number	Area Name	BIR	BI	Biological Importance	OR	Opportunities	PR	Type of Pressure
18	Eastern Tepui Upland Area	3	FL, PE, I, FW, A, R, B, M	Very high level of endemism with unique habitats in the eastern Guianan highlands.	2	Environmental education. Integration of local communities. Interconnection of the conservation policies of the three countries. Implementation of the only World Natural Heritage site in Venezuelan Canaima National Park. Historically important in the scientific knowledge of the Pantepui biogeographical region. Elaboration and implementation of management plans of the protected areas (e.g., national parks, natural monuments).	4	In the Gran Sabana uplands: uncontrolled tourism, infrastructure projects, small mining (serious problem increasing in importance), hydroelectric dams, access roads, settlements, hunting pressures, expansion of savanna and forest degradation. In the tepui highlands: uncontrolled tourism, introduction of alien taxa, burning.
19	Imataca-Southern Orinoco Delta	2	FL, PE, I, FW, A, R, B, M	Plant endemism. Some tree species with restricted geographical distribution. Some forest types with a determined floristic composition are unique in the Venezuelan Guayana.	2	Mariusa National Park at the northern edge of the area. The projected Delta del Orinoco biosphere reserve, and Canaima National Park in the south could be connected with a biological corridor through the Imataca forest reserve.	4	Agricultural frontier is advancing from north to south. Local fish fauna is under pressure from introduced African Cichlids (Tilapia). Allocated logging and mining concessions, some of them active, exist in the area. Uncontrolled small-scale mining. New construction planned.

Table 4.8-1: Description of Guiana Shield Initiative (GSI) priority areas in the Cuyuni and Mazaruni River basins

Area Number	Area Name	BIR	BI	Biological Importance	OR	Opportunities	PR	Type of Pressure
20	Cuyuni	1	FI, R, M	Biogeographically distinctive.	2	Non-timber forest products (NTFPs)	3	Logging, hunting, wildlife trade, bushmeat.
22	Lower Essequibo	2	PE, I, FW	High diversity of fish and other aquatic organisms. Monodominant forests. Rare and important ecological processes.	2	Guyana EPA is studying area. Conservation concessions. Collaboration with economic ventures in area.	3	Logging, agriculture, water pollution, hydro-electric exploitation, hunting, wildlife trade.

BIR = Biological importance rating: 3 = highest, 2 = high, 1 = moderate; Biological importance criteria: FL = floristics, PE = plant ecology, I = invertebrates, FW = fishes and freshwater ecology, A = amphibians, R = reptiles, B = birds, M = mammals, ND = not defined. OR = Opportunities rating: 3 = high, 2 = medium, 1 = low. PR = Pressure rating: 4 = highest, 3 = high, 2 = moderate, 1 = low. Source: Adapted from Huber & Foster (2003).

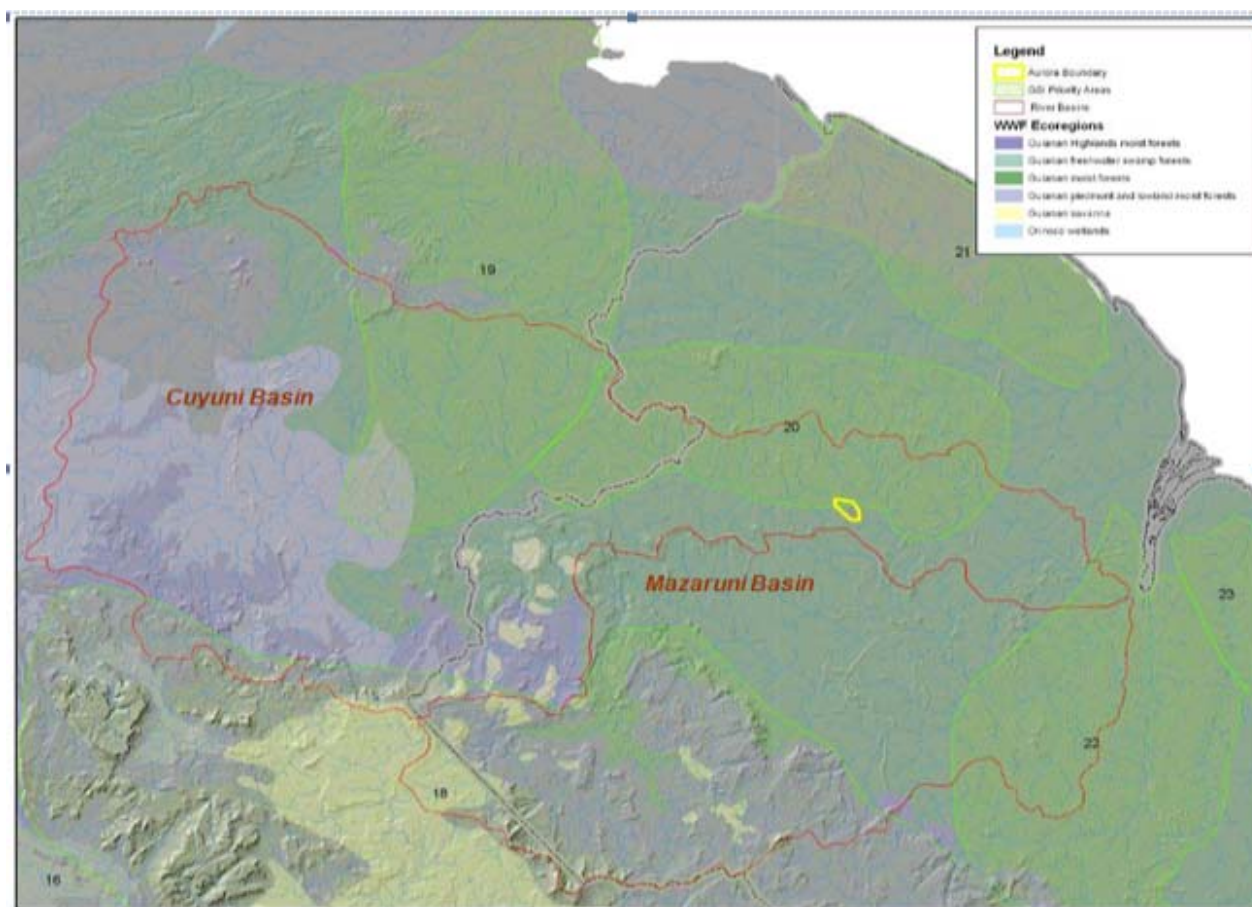


Figure 4.8-1: Guiana Shield Initiative (GSI) Priority Areas in the Cuyuni and Mazaruni River Basins.
Sources: ERM, WWF, GSI, and Lehner et al. (2008).

4.8.5 Biological Sampling Methodologies⁴

4.8.5.1 General Approach

A team of six local biologists conducted wet and dry season surveys in 2011. Senior ENVIRON consultants provided quality assurance and on-site supervision and guidance in international best practice methodologies to the Guyanese biodiversity specialists for the duration of the fieldwork and conducted quality assurance reviews of the data and reports produced. The wet season survey was conducted at the Aurora site from August 11 through August 25, 2011. The dry season survey was conducted from October 23 through November 03, 2011. With finite time and resources available, birds, bats, amphibians, reptiles, and fish were selected for survey given the number of rare taxa in these groups.

Four primary transects were used for the 2011 surveys (see **Figure 4.1-2.** and **Table 4.8-2.**). Transect lengths ranged between approximately 1.0 km and 3.5 km. Global positioning system (GPS) coordinates of wet and dry season transects at Aurora vary slightly; those presented in

⁴ For survey methods used in prior studies, see (ERM 2010).

Table 8.5-1 are from the wet season. Secondary transects 50 m in length were established off of the primary transects for sampling birds, bats, and mammals (**Table 4.8-3**). Sampling during the dry season followed the existing primary and secondary transect lines established in the wet season survey.

Table 4.8-2: Primary transect locations and descriptions for 2011 wet season terrestrial surveys at the Aurora concession				
Primary Transects	Approximate Length (m)	General Habitat Description	GPS Coordinates UTM 21N	
			Start	End
Aurora				
Accommodation Area (AA)	960	Includes access road; hilly terrain with stream channel; mixed evergreen forest on laterite and loamy soils.	0200729 0748264	0201553 0748718
Permanent Airstrip Area (PAS)	1050	East bank of the Cuyuni River; Morabukea mixed evergreen forest and Mora mixed forest on clay and laterite soils; encompasses hill slopes and stream channels.	0203212 0750115	0202176 0750304
Control Area (CA)	1770	Mixed evergreen forest on clay and laterite soils; crosses a small creek; near a seasonally-inundated swamp forest within proximity to the surveyed area.	0198418 0745249	0198598 0745592
Tailings Management Area (TMA)	3470	Morabukea-Aromata mixed evergreen forest on laterite and loamy soils; traverses a ridge and crosses two streams impacted by small-scale mining.	0193215 0748370	0195360 0745634

Table 4.8-3: Secondary transects established perpendicular to primary transects during 2011 wet season surveys at the Aurora concession. Habitat descriptions are from wet season bat surveys. Lettering follows primary transect naming conventions.

Secondary Transect	General Habitat Description	GPS Coordinates at Intersection UTM Zone 21N
AA1	Near a hollow tree with dense understory vegetation. Mora, Aromata and Baromali trees dominant.	0201553 0748718
AA2	Mora, Aromata and Baromali trees dominant.	0201553 0748718
AA3	Open sparsely populated forest on a steep slope with Mora, Aromata and Baromalli trees dominant.	0201371 0748206
AA4	Near a fallen tree, adjacent to a creek. Dense understory vegetation with Mora, Aromata and Baromalli trees dominant.	0201287 0748175
AA5	Across a tributary of Gold (aka Aurora) Creek; dense understory vegetation with Mora, Aromata and Yari Yari trees dominant.	0201104 0748194
PAS1	Open forest with Catostemma spp. and little understory vegetation.	0202949 0750277
PAS2	Open forest with Catostemma spp. and little understory vegetation.	0202949 0750277
PAS3	Near a fallen tree. Mukru, Mora, Heliconia spp. and Yarulla dominant. Open forest with little understory vegetation.	0203052 0750272
PAS4	Across a creek. Mukru, Mora and Yarulla dominant. Open forest with little understory vegetation.	0203095 0750268
PAS5	Open forest with little understory vegetation, near creek. Mukru, Mora and Yarulla dominant.	0203131 0750269
CA1	In close proximity to a swamp. Open forest with low saplings density. Mora, Baromalli and Aromata dominant.	0198541 0745631
CA2	In close proximity to a swamp. Open forest with low saplings density. Mora, Baromalli and Aromata dominant.	0198434 0745743
CA3	Open understory with assorted lianas, Mora, Trysil, and Turu palms dominant.	0198198 0745921
CA4	Open forest with low saplings density. Mora, Baromalli and Aromata dominant.	0197997 0746030

Table 4.8-3: Secondary transects established perpendicular to primary transects during 2011 wet season surveys at the Aurora concession. Habitat descriptions are from wet season bat surveys. Lettering follows primary transect naming conventions.

CA5	Open understory with assorted lianas, Mora, Trysil and Turu palms dominant.	0197725 0746186
TMA1	Across a fast flowing creek with volcanic rocks. Mora and Aromata dominant.	0193465 0747913
TMA2	Intermediate forest on a slope. Mora, lianas and epiphytes dominant.	0193671 0747770
TMA3	Ridge with Kufa, Mora and Kakaralli dominant.	0193719 0747765
TMA4	Mora, Aromats and Turu dominant.	0193921 0747569
TMA5	Across a shallow slow running creek. Turu, Mukru and Mora dominant. Open forest with sparse understory vegetation.	0194038 0747439

The following subsections present specific methods used for surveying each taxonomic group.

4.8.5.2 Botanical Surveys

Botanical surveys were conducted during both wet and dry season surveys at Aurora. Plants, including trees, vines, and epiphytes were identified to species within a one meter area on either side of each primary transect line. Additional data gathered included habitat type, soil type, percent canopy, and percent species composition based upon visual estimates of abundance using the following categories:

- dominant > 50;
- abundant 50-30;
- frequent <30;
- occasional < 20; and
- rare <10

4.8.5.3 Fish

Wet season fish sampling was conducted at four creeks on the Aurora concession (**Figure 4.8-2**), between July 31 and August 13, 2011. Dry season sampling was done at the Aurora concession from October 23 through November 3, 2011, at the same four locations sampled in the summer. During the dry season, water levels in the Cuyuni River and its tributaries in the mine site vicinity were quite low when compared to the wet season.

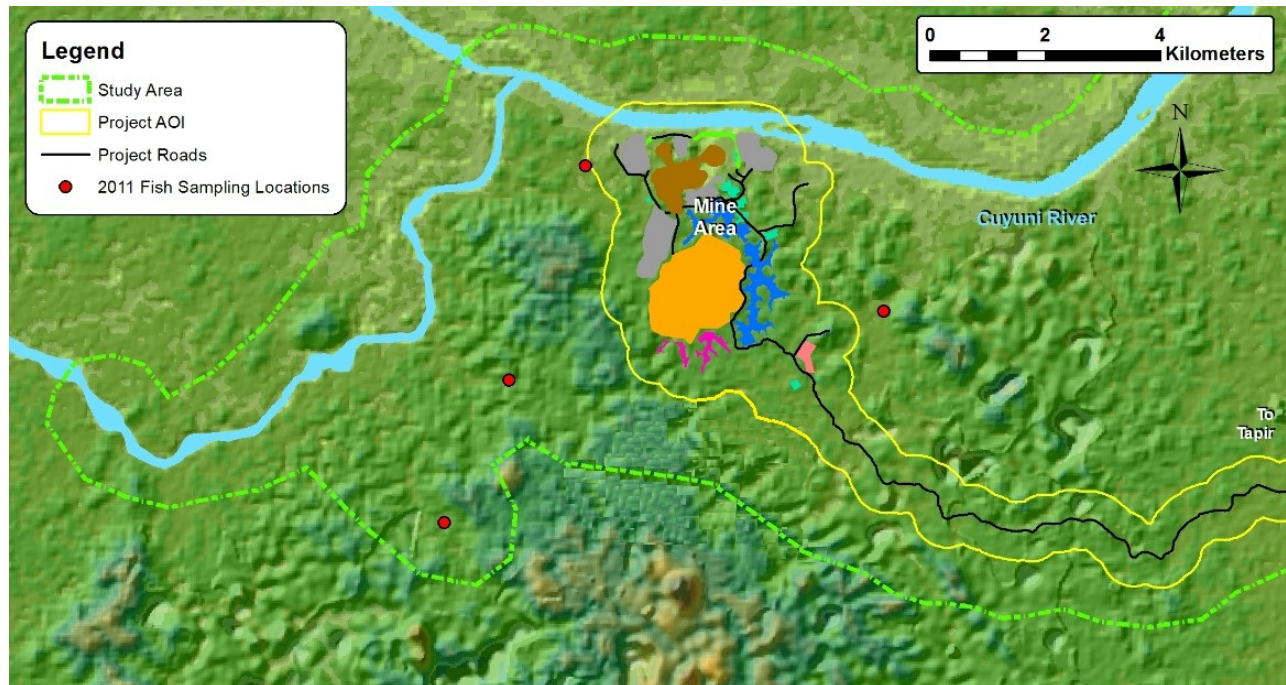


Figure 4.8-2: 2011 Wet and Dry Season Fish Sampling Locations in the Aurora Concession

Table 4.8-4: 2011 wet and dry season fish sampling dates, locations, sampling hours, and tackle

Date	Site	UTM Zone 21N	Sample Hrs	Tackle	Date	Site	UTM Zone 21N	Hrs	Tackle
Aurora Wet Season					Aurora Dry Season				
Oct 29	AC	199557 748444	96	Tangle Seine	Jul 31	AC	0199566 0748519	3	Hook and line
Oct 29	AC		4	Hook & line	Aug 1	AC		2.5	Hook and Line/Seine
Oct 30	AC		96	Tangle Seine	Aug 2	AC		2.5	Hook and Line
Oct 30	AC		4	Hook & line					
Oct 26	TA1	193038 747248	96	Tangle Seine	Aug 9	TA1	0192800 0747573	18	Hook and Line/Cast Net
Oct 26	TA1		4	Hook & line					
Oct 27	TA1		108	Tangle Seine					
Oct 27	TA1		4	Hook & line					
Nov 1	TA2 site 1	192135 744632	8	Tangle Seine	Aug 4	TA2	0192960 0744949	10	Hook and Line/Cast Net
Nov 1	TA2 site 1		4	Hook & line	Aug 5	TA2		34	Seine
Nov 1	TA2 site 2	191908 744769	96	Tangle Seine	Aug 6	TA2		5.5	Hook and Line
Nov 1	TA2 site 2		2	Hook & line					
Nov 2	TA2 site 2		96	Tangle Seine/					
Nov 2	TA2 site 2		6	Hook & line					
Nov 3	TA2 site 3	191376 745047	8	Tangle Seine					
Nov 3	TA2 site 3		4	Hook & line					
Oct 23	WMA	194368 750982	96	Tangle Seine	Aug 3	WMA	0194357 0751015	2	Hook and line
Oct 24	WMA		96	Tangle Seine	Aug 8	WMA		9	Hook and Line
Oct 25	WMA		8	Hook & Line					

Three-meter-long tangle seines (gill nets) were used to sample larger fish (>8 centimeters [cm]). Weighted nets were used for swifter moving waters and for water depths that were beyond visibility. Seines were left at each site for 48 hours then checked, and all captured fish processed immediately. Hook and line tackle was used along with tangle seines for a total of eight hours of sampling at each site.

Habitat characteristics were recorded at each site, including water depth, flow rate, and the presence of fallen trees and debris. Effort was made to incorporate representative habitat types (riffle, run and pool) within each sampled reach. Each identified habitat type in each reach was sampled until no new species were recorded.

As noted previously, an independent ichthyological study was also conducted on the Cuyuni River in early 2011. Preliminary results of which indicate an unusual and substantial depletion of fish species and abundance upstream and downstream from the Aurora site (Sidlauskas, 2011).

4.8.5.4 Amphibians and Reptiles

VES were used to sample amphibians and reptiles along transects. Auditory Encounter Surveys (AES) were also used to sample and identify frogs to genus. All individuals observed during transect surveys were recorded. Opportunistic sightings of amphibians and reptiles encountered outside of transect sites were also recorded.

4.8.5.5 Birds

Three methods were used to sample birds along each of the four transects: mist-netting, VES, and AES. Each transect was walked for about two hours twice per day at 0700 and 1500 hours.

Three 12-m x 2.6-m mist-nets were set to sample understory birds at a single location established within each transect. These locations were the same as those used for mist netting bats. Nets were left open for 6 hours, typically between 0700 and 1100 hours (4 hours), and again from 1530 to 1730 hours (2 hours). Birds were photographed and identified to species using checklists and field guides for the birds of Guyana and the Neotropics (Hilty 2003; Braun et al. 2007). All birds were released unharmed within 15 to 30 minutes of capture following identification of species.

4.8.5.6 Mammals

During the dry season survey, mammals were recorded and classified as 'opportunistic sightings' by the avifaunal team at transects using VES and AES. Signs of mammal presence were also recorded, including feces, scratch marks, and tracks. Sampling for nonflying mammals during the dry season used live traps established along the existing primary and secondary transect lines established in the wet season survey. Five secondary 50-m-long transects were established perpendicular to the primary transects (**Tables 4.8-2 and 4.8-3**). Five extra-large Sherman (10.8 cm x 1.9 cm x 38 cm) live traps were camouflaged with leaf litter and placed in selected locations on the forest floor as well as on fallen trees (capture arboreal mammals). In some cases, traps were specifically placed at the entrance of potential nesting logs. In addition to the Sherman traps, five extra-large (76 cm x 30 cm x 30 cm) Model #1112 mammal traps were also set up along these secondary transects. Traps were baited with a combination of bitter cassava (*Manihot esculenta*), pumpkin (*Cucurbita sp.*), banana (*Musa sp.*), and sweet potato (*Ipomea batatas*), and replaced whenever necessary.

Transects were analyzed to determine species diversity and richness at each site. Simpson's Index of Diversity was used to calculate species diversity:

$$1 - D = \left(\sum_{i=1}^S \frac{n_i(n_i - 1)}{N(N - 1)} \right)$$

Where

1-D = Simpson's Index of Diversity (SDI);

S = Total Number of Species in the Community;

n = the total number of organisms of a particular species; and

N = the total number of organisms of all species.

The value of this index ranges between 0 and 1. The greater the value, the greater the sample diversity.

Bats were surveyed by establishing secondary transects along each primary transect, five during the wet season and seven during the dry season. Mist nets were set up along the secondary transects and on alternate sides of the primary transect. During the wet season surveys, 5 transects nets were established along each primary transect, and during the dry season, 15 nets were used.

When siting nets, consideration was given to forest structure and the location of possible bat foraging sites where food sources such as insects or fruits had been observed. At the Accommodation Area, mist nets were established in locations where the understory was relatively open and along a local access road. Most bats quickly learn about the position of the nets due to their echolocation abilities, particularly those species that regularly patrol familiar territory. As a consequence, mist nets at the Control Area and TMA were moved to the opposite side of the transect line on the third day. Mist nets at the permanent airstrip and the accommodation areas had only two scheduled survey days, so these were left in place.

Mist nets were left open from 17:00 to 20:30 hours. Captured specimens were identified, marked, recorded, and released. Unidentified specimens were sacrificed and placed in preservative for later identification.

An active search for potential bat roosting sites was conducted in and near the sampling stations along the transects and also further away on open trails. Indirect assessment of bats was also conducted using bat droppings as an indicator of colony size, but did not enable identification to species.

4.8.6 Biological Sampling Results

4.8.6.1 Vegetation and Flora

With possible exception of clearings for indigenous settlement or agriculture, the Aurora concession was likely covered entirely by forest vegetation prior to initiation of mining and logging activities in the 19th century. This part of Guyana does not support appreciable natural open or herbaceous formations such as savannas or marshes. Species identified within this area are common to fairly common to this area and within the Moist Tropical Forest Ecoregion

(Schipper et al., 2001) of Guyana. None of the plant species identified in the Aurora concession are known to be endangered, locally endemic, or of significance to any local human communities.

The observed variations in natural forest composition are related to the topographic position in the local landscape (see **Images 4.8-2 to 4.8-4**). Four basic units were identified: riverine forests along the Cuyuni River and its narrow floodplain; riparian forests along the small streams and stream valley floors; hillslope forests; and ridge and hilltop forests. None of these forest types are geographically restricted within the greater landscape region. An exceptional type of vegetation with more restricted distribution in the area is the manicole palm (*Euterpe oleracea*) swamp. The riverine forests along the Cuyuni River are dominated by flood-tolerant species, especially various species of *Inga*, *Mora*, and *Triplaris*. The mora tree (*Mora excelsa*), a large legume with buttress roots, is typical of the floodplain forests. On the hillslopes, it is replaced by its congener *M. gonggrijpii*.



Image 4.8-2: Secondary vegetation in Golden Mile Area of the Aurora concession, March 2009
Source: Langstroth, 2009



Image 4.8-3: Cuyuni floodplain Forest with Mora Excelsa Trees, Aurora concession, March 2009
Source: Langstroth, 2009.



Image 4.8-4: Ridgetop Forest in Aurora concession, March 2009 Source: Langstroth, 2009

The largest trees overall tend to be found on the more stable ridge and hilltop forests. Mixed forest on laterite soil was dominant at all four sampling locations on the Aurora concession during the 2011 dry season botanical survey. Mora and Morabukea forests were frequently associated with the mixed forest, which also included disturbed areas and swamps. Canopy trees were the dominant plant strata, followed by lower story plants, undergrowth, and herbs.

Forest types for each Aurora transect as described during the 2011 dry season survey are as follows: all location designations are based on the original project design presented in (AMEC, 2009), which has since been consolidated as noted in Section 4.1 and **Figure 4-1**.

- *Control Area*: Mixed forest on well-drained laterite soil with Mora forest, Mora swamp, and disturbed areas with fallen trees. The primary forest has a canopy height of 20–35 m and canopy gaps of 15%–35% created by wind break and fallen trees.
- *Former Accommodation Area*: Mixed and Morabukea forest on coarse/gravelly laterite soil. Canopy height is between 20–35 m and generally closed with occasional gaps of 10%–15% due to fallen trees. Signs of human disturbance (thrown trees) were observed at areas of the transect parallel to the primary road. Other disturbed areas were as a result of wind breaks and fallen trees. Secondary vegetation was noted in disturbed areas.
- *Former TMA*: Mixed forest on coarse/gravelly laterite soil intersected by Mora and disturbed forests. Dense clusters of ferns (*Schizaea fluminensis*) were observed growing on rocky boulders. Canopy height is between 20–25 m and generally closed with occasional gaps of 10%–15% created by windblown trees. Human disturbance was evident, including a temporary Brazilian mining camp. Tree stumps from felling were also evident within the transect. Secondary vegetation was noted within disturbed areas.
- *Former Airstrip Area*: Mixed forest on lateritic soil dominated by Mora and Morabukea forests. Canopy height ranges from 25–30 m. Human disturbance was evident and included clearing for topographic surveys. Wind throw had created gaps within an otherwise closed canopy.

On the Aurora concession there were a total of 79 species documented during the dry season. During the wet season, 80 species were documented at Aurora within the Control Area, versus 56 at the former proposed location of the site airstrip.

The most frequently occurring species were *Mora gonggrijpii*, *Mora excelsa*, *Alexa imperatricis*, and *Eschweilera sagotiana* (**Table 4.8-5**). Areas of high biodiversity value, including habitat required for the survival of critically endangered or endangered species were not found within the Aurora concession during the 2011 dry season survey. The Common Baromalli — *Catostemma commune* (Polak, 1992) is regarded as an endemic species to Guyana. According to Polak (1992) this species is frequent to abundant in mixed forest areas and Mora forest and occurs principally in the Essequibo and Cuyuni River Basins. Wamara (*Swartzia leiocalycina*) is also recognized as an endemic species to Guyana. This species is widely distributed, except in parts of the Northwest District and is dominant in seasonal forest, frequent in other types of seasonal forest and in mixed forest, and occasionally in mora forest.

Table 4.8-5: Dominant and frequently occurring plant species at Aurora during the 2011 dry season. Names in bold face indicate the four most commonly occurring species in each area. (Note: all location designations are based on original project design as presented in [AMEC, 2009])

Scientific Name	Number of individuals	Relative Frequency
Former Accommodation Area (AA)		
<i>Mora excelsa</i>	782	20%
<i>Alexa imperatricis</i>	693	18%
<i>Eschweilera sagotiana</i>	303	8%
<i>Mora gonggrijpii</i>	272	7%
<i>Unonopsis glaucopetale</i>	259	7%
<i>Catostemma commune</i>	240	6%
<i>Duguetia pycnastera</i>	239	6%
<i>Licania alba</i>	238	6%
<i>Ischnosiphon arouma</i>	214	5%
<i>Tovomita schomburgkii</i>	155	4%
<i>Swartzia leiocalycina</i>	154	4%
<i>Protium decandrum</i>	136	3%
<i>Protium unifoliatum</i>	124	3%
<i>Pouteria guianensis</i>	111	3%
Former Permanent Airstrip Site (PAS)		
<i>Mora excelsa</i>	157	16%
<i>Alexa imperatricis</i>	132	14%
<i>Catostemma commune</i>	99	10%
<i>Tovomita schomburgkii</i>	98	10%
<i>Protium decandrum</i>	91	10%
<i>Eschweilera sagotiana</i>	85	9%
<i>Unonopsis glaucopetale</i>	82	9%
<i>Pouteria guianensis</i>	65	7%
<i>Swartzia leiocalycina</i>	60	6%
<i>Licania alba</i>	51	5%
<i>Licania densiflora</i>	35	4%
Control Area (CA)		
<i>Mora gonggrijpii</i>	211	17%
<i>Alexa imperatricis</i>	103	10%
<i>Paypayrola longifolia</i>	65	10%
<i>Mora excelsa</i>	60	8%
<i>Duguetia pycnastera</i>	49	8%
<i>Eschweilera sagotiana</i>	48	7%
<i>Pouteria guianensis</i>	46	7%
<i>Unonopsis glaucopetale</i>	41	17%

Table 4.8-6: Dominant and frequently occurring plant species at Aurora during the 2011 dry season. Names in bold face indicate the four most commonly occurring species in each area. (Note: all location designations are based on original project design as presented in [AMEC, 2009])

Former Tailings Management Area (TMA)		
Alexa imperatricis	257	30%
<i>Duguetia pycnastera</i>	146	17%
Mora excelsa	100	12%
Eschweilera sagotiana	77	9%
<i>Licania alba</i>	71	8%
<i>Catostemma commune</i>	69	8%
<i>Mora gonggrijpii</i>	62	7%
<i>Jessenia bataua</i>	50	6%
<i>Unonopsis glaucopetale</i>	31	4%

4.8.7 Fish

No previous systematic fish sampling had been done at the Cuyuni River in Guyana prior to the 2006–2007 surveys. However, in Venezuela, 135 species of fish were documented occurring along the Cuyuni and its tributaries in lowland Venezuela (Machado-Allison et al., 2000). A photograph of a typical fish within the Cuyuni River is provided in **Image 4.8-5**.

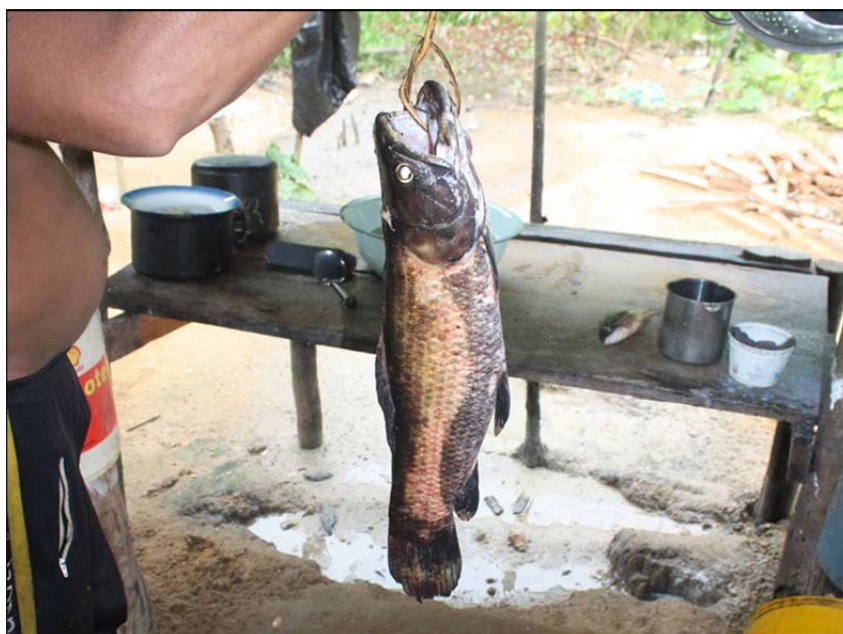


Image 4.8-5: *Hoplias malabaricus* (haimara) caught by small-scale miners at camp near Alligator Creek outside of the Aurora concession (area not owned by GGI), April 2009. Source: Langstroth, 2009

A total of fish 59 species were reported by the 2006, 2007, and 2009 surveys. None of the species reported are known to be Endangered or Critically Endangered per the IUCN Red list of Threatened Species or to be endemic to Guyana or the Cuyuni river basin. Some of the species are migratory in the Cuyuni River, but are not know to use streams within the Aurora concession for any significant part of their life cycle.

Although 45 species of fish were collected in 2009, only a few individuals were collected per species. The sampled tributaries of the Julian Ross Itabu were heavily contaminated from tailings runoff and oil from operations further upstream, which resulted in significant sedimentation and possibly depleted water quality. At one particular creek, the sedimentation was so severe that no species were collected during sampling. A photograph of a sediment-laden stream in the vicinity of the project site is provided in **Image 4.8-6**.



Image 4.8-6: Fine sediment along lower reach of Alligator Creek, affected by upstream ASM activity, April 2009. Source: Langstroth, 2009

Fourteen species representing seven families were documented at the four creeks surveyed on the Aurora concession July–September 2011. Eleven species were recorded at the TMA. Nine new species were recorded at this area. Four species were recorded at Aurora Creek, and five species were recorded at the water management site.

Only two of the four sites surveyed during this assessment were surveyed during the baseline characterization survey conducted in 2009. The streams that were sampled were located in the mine water and TMA. During the previous survey a total of six species were recorded at the mine water site while two species were recorded at the TMA.

In comparison, 128 fish representing 26 species and 9 families were observed at 4 locations. Site TA1 had the most fish and the highest number of species, accounting for 35% and 53%, respectively of total catch. In contrast, only 13 fish representing 7 species were captured at the MWP site, accounting for 10% and 29%, respectively, of the total catch. However, this may have resulted from heavy rains experienced during the time of sampling. The rains caused overtopping of the stream banks during the sampling period reducing the effectiveness of sample method.

Table 4.8-6: Fish sampled at Aurora during 2011 wet and dry season surveys									
Common Name	Scientific Name	Family	Aurora - Dry			Aurora - Wet			
			S1	S2	S3	AC	WM	TA1	TA2
Common Patwa	<i>Cichlasoma bimaculatum</i>	Cichlidae					X		
Sunfish	<i>Crenicichla alta</i>	Cichlidae		X					
Sunfish	<i>Crenicichla johanna</i>	Cichlidae	X						
	<i>Crenicichla</i> sp.	Cichlidae						X	
	<i>Crenicichla llugubris</i>	Cichlidae					X		X
Sugar Fish	<i>Erythrinus erythrinus</i>	Erythrinidae			X				
Sandgrinder Patwa	<i>Guianacara sphenozona</i>	Cichlidae		X	X			X	
Himara	<i>Hoplias aimara</i>	Erythrinidae							
Haimara	<i>Hoplias macrophthalmus</i>	Erythrinidae	X			X		X	
Huri	<i>Hoplias malabaricus</i>	Erythrinidae	X	X	X	X	X		
Daray	<i>Leporinus</i> sp.	Anostomidae						X	
Glass tetra	<i>Moenkhausia oligolepis</i>	Characidae		X				X	X
	<i>Moenkhausia</i> sp	Characidae			X	X	X	X	X
Larima	<i>Pimelodus blochii</i>	Pimelodidae	X						X
Kassie	<i>Rhamdia</i> sp.	Heptapteridae	X	X	X	X			X
Yakutu	<i>Prochilodus rubrotaeniatus</i>	Prochilodontidae							X
Smoke hassar		Loricariidae						X	
Yarrow	<i>Hoploerythrinus unitaeniatus</i>	Erythrinidae					X		

The aquatic habitats within the Aurora concession have generally been severely degraded by ASM activities upstream and are not of significant value for any fish species of conservation concern (e.g., threatened species, restrict-range species, migratory species, or species of importance to local communities). A February 2011 survey of the Cuyuni River by Dr. Brian Sidlauskas and colleagues found a total of 41 species at the sampling location immediately upstream of the Aurora camp; data were obtained from Smithsonian National Museum of

Natural History Division of Fishes Collections database: <http://collections.mnh.si.edu/searches/fishes/>, and are generally corroborated by (Sidlauskas, 2011). A notable difference between these Cuyuni River fish and those from the waters within the Aurora concession is the very low importance of cichlids and erythrinids in the Cuyuni sample (i.e., only one specimen of one species in each family was collected by Sidlauska et al.) and their high importance in the concession area waters. Rather, the Cuyuni samples indicate a high importance of catfish (i.e., various families of the order Siluriformes) and members of the Characidae. These findings suggest there is little or no connectivity between the small, first order tributaries and the very large Cuyuni River.

4.8.8 Amphibians

A total of 12 families and 52 species of amphibians were reported by the 2006, 2007, 2009, and 2011 surveys. All of the species encountered are common to the wider geographic area of Guyana and many are found across the entire Guianan-Amazonian lowlands region. None of the species reported are categorized as endangered or threatened, and only one species, *Stefania evansi*, is considered to be endemic to Guyana.

During the combined 2011 wet and dry seasons at Aurora, 47 species representing 7 families were observed (**Table 4.8-7**). Numbers were higher during the dry than the wet season, perhaps due in part to heavy dry season rainfall, with more species observed at the TMA during both seasons.

Table 4.8-7: Summary of amphibians identified during 2011 wet and dry season surveys at Aurora												
Family	Scientific Name	Common Name	Aurora - Dry ¹					Aurora - Wet				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
AROMOBATIDAE												
	<i>Allobates femoralis</i>	Brilliant-thighed Poison Frog	X	X	X	X						
BUFONIDAE												
	<i>Rhaebo guttatus</i>	Smooth-Sided Toad		X		X						X
	<i>Rhaebo nasicus</i>	Werner's Toad						X		X		X
	<i>Rhinella marina</i>	Giant Marine Toad, Crapo	X		X				X	X		X
	<i>Rhinella</i> cf. <i>margaritifera</i>	Toad, Crapo		X		X						
CENTROLENIDAE												
	<i>Cochranella</i> sp.	Cochran Frog			X	X						
	<i>Ameerega trivittata</i>	Three-striped Arrow-poison Frog							X	X		
	<i>Ameerega hahneli</i>	Arrow-poison Frog	X	X	X	X						
	<i>Stefania evansi</i>	Groete Creek Treefrog				X			X	X		
HYLIDAE												
	<i>Hypsiboas boans</i>	Giant Gladiator Treefrog	X	X	X	X				X		
	<i>Hypsiboas calcaratus</i>	Troschel's Treefrog				X						
	<i>Hypsiboas cincerascens</i>	Demerara Falls Treefrog			X			X	X	X	X	X
	<i>Hypsiboas crepitans</i>	Rattle-voiced Treefrog			X	X						
	<i>Hypsiboas fasciatus</i>	Gunther's Banded Treefrog			X							
	<i>Hypsiboas geographicus</i>	Map Treefrog						X	X			
	<i>Hypsiboas multifasciatus</i>	Many-banded Treefrog			X							
	<i>Hypsiboas punctatus</i>	Polka-dot Treefrog						X				
	<i>Hypsiboas raniceps</i>	Chaco Treefrog			X							
	<i>Osteocephalus</i> sp.		X		X							
	<i>Osteocephalus taurinus</i>	Manaus Slender- legged Treefrog	X			X				X		

Table 4.8-7: Summary of amphibians identified during 2011 wet and dry season surveys at Aurora												
	<i>Phyllomedusa bicolor</i>		X		X	X						
	<i>Phyllomedusa tomopterna</i>	Tiger-striped Leaf Frog			X							
	<i>Pseudis paradoxa</i>	Paradox Frog								X		
	<i>Scinax ruber</i>	Red Snouted Treefrog	X	X	X	X	X		X	X		
	<i>Trachycephalus coriaceus</i>	Suriname Casque-headed Treefrog				X						
	<i>Trachycephalus resinifictrix</i>	Kunawalu Casque-headed Treefrog	X									
LEPTODACTYLIDAE												
	<i>Hydrolaetare schmidtii</i>	Schmidt's Forest Frog				X						
	<i>Leptodactylus</i> sp.								X			
	<i>Leptodactylus hylaedactylus</i>	Napo Tropical Bullfrog		X	X	X						
	<i>Leptodactylus knudensi</i>	Knudsen's Thin-toed Frog	X		X	X		X	X	X	X	X
	<i>Leptodactylus lineatus</i>	Gold-striped Frog						X		X		X
	<i>Leptodactylus longirostris</i>	Longnose Frog	X								X	
	<i>Leptodactylus mystaceus</i>	Amazon Basin White-lipped Frog			X	X					X	
MICROHYLIDAE												
	<i>Chiasmocleis shudikarensis</i>	Guyana Humming Frog			X							
	<i>Synapturanus mirandaribeiroi</i>	Miranda's Disc Frog	X	X	X							
STRABOMANTIDAE												
	<i>Pristimantis inguinalis</i>	New River Robber Frog				X						
	<i>Pristimantis</i> sp.	Robber Frog				X						

1. CA=Control Area; AA=Accommodation Area; TMA=Tailings Management Area; PAS=Permanent Airstrip; OPP=Opportunistic sightings off transect; area designations are based on early configuration of project features per (AMEC, 2009)]

All Anuran species recorded in the 2011 surveys, including *Stefania evansi*, are listed by the IUCN Red as Least Concern (IUCN 2012). None of the terrestrial or freshwater herpetofaunal species recorded in Guyana can be classified as migratory or congregatory. A photograph of a typical amphibian found within the Aurora concession is provided in **Image 4.8-7**.



Image 4.8-7: *Allobates femoralis*, an abundant forest floor frog in the Aurora concession, April 2009 Source: Langstroth, 2009

4.8.9 Non-avian Reptiles

Following current understanding of the evolution of birds, it is clear that birds are in fact reptiles. For the sake of scientific accuracy, we use the term “non-avian reptiles” for the artificial group that includes all living reptiles except birds. This includes the Testudines (turtles and tortoises), Squamata (lizards, snakes, and amphisbaenids), and Crocodylia (alligators, caiman, etc.).

4.8.9.1 Testudines

The 2011 wet season survey at Aurora identified three species of turtles and tortoises: yellow-foot tortoise (*Chelonoidis denticulata*), twist-necked turtle (*Platemys platycephala*), and spot-legged turtle (*Rhinoclemmys punctulata*). Neither the twist-necked turtle nor the spot-legged

turtle is listed by the IUCN. Yellow-footed tortoise is listed as Vulnerable although it is widely distributed and abundant in Guyana and northern South America. Previous studies at Aurora (March 2010) observed only *C. denticulata*. No turtles have been observed in the Cuyuni River by any of the surveys.

4.8.9.2 Squamata

In the 2011 Aurora wet season survey, 48 snakes and lizards representing 11 species and 8 families were noted. Snakes were in low numbers, with only one or two of each species observed. Of the lizards, *Ameiva ameiva* was most common. In comparison, the 2011 dry season surveys yielded 70 individuals representing 16 species and 10 families, of which 7 species were snakes. None of the species observed are listed as threatened by the IUCN or are restricted range species. A photograph of a typical lizard of the Aurora concession is provided in **Image 4.8-8**.



Image 4.8-8: *Anolis planiceps*, a common forest floor lizard in the Aurora concession, April 2009.
Source: Langstroth, 2009

4.8.9.3 Crocodylia

In 2011, dwarf caiman (*Paleosuchus palpebrosus*) was observed on the Aurora concession and in the Cuyuni River. Two were observed on the concession at the accommodation area during the dry season, and five were seen off of the Aurora transects during the wet season.

Paleosuchus palpebrosus is listed as Least Concern (IUCN 2012). Previous surveys have also reported smooth-fronted caiman (*Paleosuchus trigonatus*) and black caiman (*Melanosuchus niger*) from the Cuyuni River; both species are listed as Least Concern by the IUCN.

4.8.10 Birds

A total of 308 bird species from 54 families were reported from all surveys combined (2006 through 2011). The 2006 and 2007 field data indicated the presence of the sun parakeet (*Aratinga solstitialis*), an endangered species under the 2012 IUCN Red List. This is either a misidentification or an usual sighting of a vagrant, as this species is not known to inhabit the Cuyuni River basin and is associated with dry forest hills surrounding the Rupununi Savannas (Karasabai area and Karanambo) and areas of adjacent Brazil (BirdLife International, 2013). No sun parakeets were observed during the 2009 or 2011 surveys. A 2006 sighting from the Demarara River (BirdLife International, 2013) is presumed to represent a vagrant and not to represent a population in the area.

A total of 11 migratory species were reported during all surveys (**Table 4.8-8**). Of these, 5 are austral migrants, 3 are Nearctic migrants, 1 is autumnal, and 1 has a complex migration pattern.

Table 4.8-8. Migratory bird species reported from all surveys		
Scientific Name	Common Name	Migratory Pattern
<i>Conopias parvus</i>	Yellow-throated Flycatcher	AMN
<i>Progne tapera</i>	Brown-chested Martin	AUS
<i>Legatus leucophaius</i>	Piratic Flycatcher	AUS
<i>Tyrannus savanna</i>	Fork-tailed Flycatcher	AUS
<i>Tyrannus albogularis</i>	White-throated Kingbird	AUS
<i>Tyrannus melancholicus</i>	Tropical Kingbird	AUS
<i>Elanoides forficatus</i>	Swallow-tailed Kite	COMPLEX
<i>Coccyzus americanus</i>	Yellow-billed Cuckoo	NEA
<i>Actitis macularius</i>	Spotted Sandpiper	NEA
<i>Tringa solitaria</i>	Solitary Sandpiper	NEA

In addition, eight species were recorded as endemics to either Guyana or the Guianan Shield (Milensky et al., 2005), none of which is considered to be range-restricted (i.e., range of less than 50,000 km²) (**Table 4.8-9**).

Table 4.8-9: Guianan Shield endemic bird species (according to Milensky et al., 2005) reported from the Aurora concession during all field surveys with IUCN Category and range (Birdlife International, 2013).

Scientific Name	Common Name	IUCN Category	Range
<i>Cyanocorax cayanus</i>	Cayenne Jay	LC	1,160,000 km ²
<i>Perissocephalus tricolor</i>	Capuchinbird	LC	1,660,000 km ²
<i>Pionites melanocephalus</i>	Black-headed Parrot	LC	2,920,000 km ²
<i>Pionopsitta caica</i>	Caica Parrot	LC	1,290,000 km ²
<i>Myrmeciza atrothorax</i>	Black-throated Antbird	LC	6,800.00 km ²
<i>Myrmotherula gutturalis</i>	Brown-bellied Antwren	LC	1,090,000 km ²
<i>Monasa atra</i>	Black Nunbird	LC	1,730,000 km ²
<i>Crax alector</i>	Black Curassow	VU	2,100,000 km ²
<i>Aratinga solstitialis</i>	Sun Parakeet	EN	65,300 km ²

During the 2011 wet season survey at Aurora, 136 species of birds were observed or netted, and an additional 24 were seen outside of the transects. Fifteen species of birds were captured in mist nets, including the white-bearded manakin (*Manacus manacus*), gray-breasted sabrewing (*Campylopterus largipennis*), plain-winged antwren (*Myrmotherula behni*) and pygmy kingfisher (*Chloroceryle aenea*) which were observed only in mist nets and neither seen nor heard along the transects.

As noted in **Table 4.8-10**, during the dry season survey at Aurora, a total 457 birds belonging to 66 species and 16 families were observed, a decrease of approximately 70% from wet season counts. It is estimated that the true species richness for avifauna is around 200–250 species.

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys												
FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
ACCIPITRIDAE												
	<i>Harpia harpyja</i>	Harpy Eagle			X							
	<i>Leucopternis albicollis</i>	White Hawk	X									
	<i>Spizaetus ornatus</i>	Ornate Hawk-Eagle										
ALCEDINIDAE												
	<i>Chloroceryle aenea</i>	American Pygmy Kingfisher				X	X					
	<i>Chloroceryle amazona</i>	Amazon Kingfisher					X					
	<i>Chloroceryle americana</i>	Green Kingfisher										
	<i>Megaceryle torquata</i>	Ringed Kingfisher					X					
APODIDAE												
	<i>Chaetura cinereiventris</i>	Gray-rumped Swift			X							
	<i>Chaetura spinicaudus</i>	Band-rumped Swift					X					
	<i>Chaetura</i> sp.	Chaetura Swift		X		X						
	<i>Chaetura brachyura</i>	Short-tailed Swift	X									
ARDEIDAE												
	<i>Tigrisoma lineatum</i>	Rufescent Tiger-Heron	X									
BUCCONIDAE												
	<i>Notharchus macrorhynchos</i>	Guyana Puffbird	X									
CAPRIMULGIDAE												
	<i>Nyctidromus albicollis</i>	Common Pauraque					X					

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys												
FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
CARDINALIDAE												
	<i>Caryothraustes canadensis</i>	Yellow-green Grosbeak	X		X		X					
	<i>Saltator grossus</i>	Slate-colored Grosbeak	X	X								
	<i>Periporphyrus erythromelas</i>	Red-and-black Grosbeak		X	X	X	X					
CATHARTIDAE												
	<i>Cathartes aura</i>	Turkey Vulture		X								
	<i>Cathartes melambrotus</i>	Greater Yellow- headed Vulture			X							
	<i>Coragyps atratus</i>	Black Vulture				X						
COEREVIDAE												
	<i>Coereba flaveola</i>	Bananaquit	X	X	X	X	X					
COLUMBIDAE												
	<i>Columba plumbea</i>	Plumbeous Pigeon	X	X	X	X	X	X	X	X	X	X
	<i>Geotrygon montana</i>	Ruddy Quail-Dove	X									
	<i>Leptotila rufaxilla</i>	Gray-fronted Dove				X						X
	<i>Patagioenas subvinacea</i>	Ruddy Pigeon	X		X		X	X	X	X	X	X
CORVIDAE												
	<i>Cyanocorax cayanus</i>	Cayenne Jay	X									
COTINGIDAE												
	<i>Lipaugus vociferans</i>	Screaming Piha	X		X	X		X	X	X	X	X
	<i>Phoenicircus carnifex</i>	Guianan Red-Cotinga	X			X		X	X	X	X	X
	<i>Perissocephalus tricolor</i>	Capuchinbird										
	<i>Schiffornis turdina</i>	Thrush-like Schiffornis										

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys												
FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
CRACIDAE												
	<i>Crax alector</i>	Black Curassow	X									
CUCULIDAE												
	<i>Crotophaga ani</i>	Smooth-billed Ani										
	<i>Penelope marail</i>	Marail Guan										
	<i>Ortalis motmot</i>	Little chachalaca										
	<i>Penelope jacquacu</i>	Spix's Guan			X	X						
CUCULIDAE												
	<i>Piaya cayana</i>	Squirrel Cuckoo					X					X
	<i>Piaya melanogaster</i>	Black-bellied Cuckoo	X		X		X	X		X		X
DENDROCOLAPTIDAE												
	<i>Glyphorynchus spirurus</i>	Wedge-billed Woodcreeper	X	X	X	X	X	X	X	X	X	X
EURYPIDAE												
	<i>Eurypyga helias</i>	Sun bittern	X									
FALCONIDAE												
	<i>Micrastur mirandollei</i>	Slaty-backed Forest-Falcon		X				X			X	
	<i>Micrastur ruficollis</i>	Barred Forest-Falcon						X		X	X	
	<i>Micrastur gilvicollis</i>	Lined Forest-Falcon						X	X	X	X	
	<i>Micrastur</i> sp.	Forest-Falcon	X									
	<i>Ibycter americanus</i>	Red-throated Caracara	X	X								

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys												
FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
FORMICARIIDAE												
	<i>Hylopezus macularius</i>	Spotted Antpitta				X		X		X	X	X
	<i>Formicarius analis</i>	Black-faced Ant-thrush	X		X			X				
	<i>Formicarius colma</i>	Rufous-capped Ant-thrush	X		X	X		X			X	X
	<i>Myrmothera campanisoma</i>	Thrush-like Antpitta	X	X				X	X	X		X
FURNARIIDAE												
	<i>Dendrocincla fuliginosa</i>	Plain-brown Woodcreeper	X					X		X		X
	<i>Xenops minutus</i>	Plain Xenops	X			X	X				X	X
	<i>Xiphorhynchus guttatus</i>	Buff-throated Woodcreeper	X			X		X	X	X	X	X
	<i>Xiphorhynchus pardalotus</i>	Chestnut-rumped Woodcreeper	X	X		X		X	X		X	X
GALBULIDAE												
	<i>Galbula dea</i>	Paradise Jacamar		X	X	X		X				X
	<i>Galbula albirostris</i>	Yellow-billed Jacamar				X						
	<i>Jacamerops aureus</i>	Great Jacamar										
HIRUNDINIDAE												
	<i>Atticora fasciata</i>	White-banded Swallow					X					
	<i>Progne chalybea</i>	Gray-breasted Martin					X					
	<i>Riparia riparia</i>	Black-collared Swallow					X					
	<i>Tachycineta albiventer</i>	White-winged Swallow					X					
ICTERIDAE												
	<i>Psarocolius viridis</i>	Green Oropendola	X	X	X	X						
	<i>Cacicus haemorrhous</i>	Red-rumped Cacique				X						
NYCTIBIIDAE												
	<i>Nyctibius griseus</i>	Common Potoo					X					

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys												
FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
ODONTOPHORIIDAE												
	<i>Odontophorus gujanensis</i>	Marbled Wood-Quail				X						
PARULIDAE												
	<i>Phaeothlypis rivularis</i>	River Warbler	X	X	X							
PICIDAE												
	<i>Campephilus rubicollis</i>	Red-necked Woodpecker	X		X			X	X	X	X	X
	<i>Celeus undatus</i>	Waved Woodpecker			X			X	X	X	X	X
	<i>Dryocopus lineatus</i>	Lineated Woodpecker		X								X
	<i>Melanerpes cruentatus</i>	Yellow-tufted Woodpecker				X						
	<i>Piculus flavigula</i>	Yellow-throated Woodpecker	X		X			X	X	X	X	X
	<i>Veniliornis passerinus</i>	Little Woodpecker				X						
PIPRIDAE												
	<i>Manacus manacus</i>	White-bearded Manakin	X		X		X		X			X
	<i>Pipra erythrocephala</i>	Golden-headed Manakin			X							
	<i>Pipra pipra</i>	White-crowned Manakin			X	X	X	X	X	X	X	X
	<i>Schiffornis turdina</i>	Thrush-like Schiffornis	X			X				X		X
	<i>Tyranneutes virescens</i>	Tiny Tyrant-Manakin				X		X	X	X	X	X
POLIOPTILIDAE												
	<i>Ramphocaenus melanurus</i>	Long-billed Gnatwren	X	X	X	X	X					
PSOPHIDAE												
	<i>Psophia crepitans</i>	Gray-winged Trumpeter					X					
PSITTACIDAE												
	<i>Amazona amazonica</i>	Orange-winged Parrot			X			X	X		X	X
	<i>Amazona farinosa</i>	Mealy Parrot						X	X	X	X	X
	<i>Ara</i> sp.	Macaw										
	<i>Ara ararauna</i>	Blue-and-yellow Macaw	X		X	X		X	X	X		

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys

FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
	<i>Brotogetis chrysopterus</i>	Golden-winged Parakeet	X	X	X			X				
	<i>Derophtus accipitrinus</i>	Red-fan Parrot		X								
	<i>Forpus passerinus</i>	Green-rumped Parrotlet				X						X
	<i>Forpus</i> sp.	Parrotlet										
	<i>Pionites melanocephalus</i>	Black-headed Parrot	X	X	X	X						
	<i>Pionopsitta caica</i>	Caica Parrot	X			X		X	X	X	X	X
	<i>Pionus fuscus</i>	Dusky Parrot			X			X	X			X
	<i>Pionus menstruus</i>	Blue-headed Parrot	X			X		X	X		X	X
RAMPHASTIDAE												
	<i>Pteroglossus aracari</i>	Black-necked Aracari	3		3			4			2	
	<i>Ramphastos tucanus</i>	Red-billed Toucan	3	1	2			4	1	5	2	3
	<i>Ramphastos vitellinus</i>	Channel-billed Toucan	1		2	2		2	2			
THAMNOPHILIDAE												
	<i>Cercomacra cinerascens</i>	Gray Antbird	X		X							
	<i>Cercomacra tyrannina</i>	Dusky Antbird					X		X	X	X	X
	<i>Cymbilaimus lineatus</i>	Fasciated Antshrike	X	X				X	X	X	X	
	<i>Gymnopithys rufigula</i>	Rufous-throated Antbird	X		X	X	X	X	X	X	X	X
	<i>Herpsilochmus stictocephalus</i>	Todd's Antwren		X	X	X						
	<i>Herpsilochmus sticturus</i>	Spot-tailed Antwren	X	X	X	X						
	<i>Hylophylax</i> sp.	Antbird				X						
	<i>Hypocnemis cantator</i>	Guianan Warbling Antbird	X	X		X	X	X	X	X	X	X
	<i>Myrmoborus leucophrys</i>	White-browed Antbird	X									
	<i>Myrmothera campanisona</i>	Thrush-like Antpitta										
	<i>Myrmotherula behni</i>	Plain-winged Antwren				X	X					
	<i>Myrmotherula brachyura</i>	Pygmy Antwren	X									
	<i>Myrmotherula guttata</i>	Rufous-bellied antwren	X		X	X		X	X	X	X	X

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys

FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
	<i>Myrmotherula longipennis</i>	Longed-winged Antwren	X			X		X	X	X	X	X
	<i>Myrmotherula menetriesii</i>	Gray Antwren	X	X		X	X	X	X	X	X	X
	<i>Pithys albifrons</i>	White-plumed Antbird	X	X		X	X	X	X	X	X	X
	<i>Thamnomanes ardesiacus</i>	Dusky- throated Antshrike	X	X				X	X	X	X	X
	<i>Thamnomanes caesius</i>	Cinereus Antshrike	X			X					X	X
	<i>Thamnophilus murinus</i>	Mouse-colored Antshrike	X	X		X		X	X	X	X	X
THRAUPIDAE												
	<i>Tachyphonus surinamus</i>	Fulvous-crested Tanager		X		X						
	<i>Tangara gyrola</i>	Bay-headed Tanager	X	X								
	<i>Tangara mexicana</i>	Turquoise Tanager	X									
	<i>Tangara</i> sp.	Tanager				X						
THRESKIORNITHIDAE												
	<i>Mesembrinibis cayennensis</i>	Green Ibis					X					
TINAMIDAE												
	<i>Crypturellus</i> sp.	Tinamou			X	X						
	<i>Crypturellus variegatus</i>	Variegated Tinamou	X		X	X						
	<i>Tinamus major</i>	Great Tinamou					X					
TITYRIDAE												
	<i>Tityra cayana</i>	Black-tailed Tityra				X						
TROCHILIDAE												
	<i>Adelomyia melanogenys</i>	Speckled Hummingbird										
	<i>Amazilia brevirostris</i>	White-chested Emerald	X					X				X
	<i>Amazilia</i> sp. 1	Hummingbird										
	<i>Amazilia</i> sp. 2	Emerald		X	X							
	<i>Amazilia</i> sp .3	Emerald	X	X			X					

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys

FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
	<i>Amazilia tobaci</i>	Copper-rumped Hummingbird										
	<i>Campylopterus largipennis</i>	Gray-breasted Sabrewing				X	X				X	X
	<i>Chlorestes notatus</i>	Blue-chinned Sapphire										
	<i>Coeligena coeligena</i>	Bronzy Inca										
	<i>Colibri thalassinus</i>	Green Violetear										
	<i>Doryfera johannae</i>	Blue-fronted Lancebill										
	<i>Heliothryx auritus</i>	Black-eared Fairy	X			X		X	X		X	X
	<i>Hylocharis cyanus</i>	White-chinned Sapphire										
	<i>Phaethornis ruber</i>	Reddish Hermit	X	X		X		X	X		X	X
	<i>Phaethornis</i> sp.	Hermit			X			X	X			X
	<i>Phaethornis superciliosus</i>	Eastern Long-tailed Hermit	X	X	X			X	X	X		X
	<i>Phaethornis bourcierii</i>	Long-tailed Hermit		X	X	X	X			X	X	X
	<i>Phaethornis hispidus</i>	White-bearded Hermit										
	<i>Phaethornis rupurumii</i>	Streak-throated Hermit										
	<i>Thalurania furcata</i>	Fork-tailed Woodnymph	X		X	X	X	X	X	X	X	X
	<i>Topaza pella</i>	Crimson Topaz	X					X				X
TROGLODYTIDAE												
	<i>Cyphorhinus arada</i>	Musician Wren	X		X	X			X		X	X
	<i>Campylorhynchus griseus</i>	Buff-breasted Wood-Wren		X								
	<i>Henicorhina leucosticta</i>	White-breasted Wood-wren										
	<i>Thryothorus coraya</i>	Coraya Wren		X	X				X			X
	<i>Thryothorus leucotis</i>	Buff-breasted Wren										
	<i>Troglodytes musculus</i>	Southern House Wren										

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys

FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
TROGONIDAE												
	<i>Trogon rufus</i>	Black-throated Trogon				X					X	X
	<i>Trogon viridis</i>	White-tailed Trogon	X		X	X		X	X	X	X	X
	<i>Trogon violaceus</i>	Violaceous Trogon	X						X	X		X
TURDIDAE												
	<i>Platycichla leucops</i>	Pale-eyed Thrush										
TYRANNIDAE												
	<i>Attila spadiceus</i>	Bright-rumped Attila	X		X	X			X	X	X	
	<i>Attila cinnamomeus</i>	Cinnamon Attila										
	<i>Colonia colonus</i>	Long-tailed Tyrant										
	<i>Conopias parvus</i>	Yellow-throated Flycatcher				X						
	<i>Fluvicola pica</i>	Pied Water-Tyrant										
	<i>Legatus leucophaeus</i>	Piratic Flycatcher										
	<i>Lophotriccus galeatus</i>	Helmented Pygmy-Tyrant	X	X	X	X		X				X
	<i>Megarynchus pitangua</i>	Boat-billed Flycatcher										
	<i>Myiarchus</i> sp.	Myiarchus Flycatcher	2									
	<i>Myiarchus tuberculifer</i>	Dusky-capped Flycatcher										
	<i>Myiobius barbatus</i>	Whiskered Flycatcher			X			X		X	X	X
	<i>Platyrinchus coronatus</i>	golden-crowned spadebill	X		X	X	X	X	X	X	X	X
	<i>Tolmomyias assimilis</i>	Zimmer's Flycatcher	X	X								
	<i>Tolmomyias flaviventris</i>	Yellow-breasted Flycatcher		X								
	<i>Tolmomyias</i> sp.	Tolmomyias Flycatcher	X									
	<i>Tyrannus savanna</i>	Fork-tailed Flycatcher					X					
	<i>Tyrannus melancholicus</i>	Tropical Kingbird					X					

Table 4.8-10: Bird species observed at Aurora during 2011 wet and dry season surveys												
FAMILY	SCIENTIFIC NAME ¹	COMMON NAME	AURORA WET ²					AURORA - DRY				
			CA	AA	TMA	PAS	OPP	CA	AA	TMA	PAS	OPP
VIREONIDAE												
	<i>Hylophilus musicicapinus</i>	Buff-cheeked Greenlet	X	X	X	X						
	<i>Hylophilus thoracicus</i>	Lemon-chested Greenlet		X								
	<i>Virolanius leucotis</i>	Slaty-capped Shrike-Vireo			X							

¹. Individuals that could not be definitely identified to species level due to limited observability are indicated by "sp." after the genus. The use of "sp." here does not imply that these are "unknown" and potentially new species to science, simply that the species could not be determined in the field.

². CA=Control Area; AA=Accommodation Area; TMA=Tailings Management Area; PAS=Permanent Airstrip; OPP=Opportunistic sightings off transect [area designations are based on early configuration of project features per AMEC (2009)]

The harpy eagle and the ornate hawk eagle are listed as Near Threatened by the IUCN Red List (IUCN, 2012). The black currasow and the ruddy pigeon are listed as Vulnerable.⁵ One migrant species, the spotted sandpiper (*Actitis macularius*), was recorded within the Guyana Goldfields concession areas. Another nine species are endemics to the Guianan shield, namely *Pionopsitta caica*, *Pteroglossus viridis*, *Hypocnemis cantator*, *Myrmoborus leucophry*, *Pithys albifrons*, *Phoenicircus carnifex*, *Notharchus macrorhynchos*, *Pionus fuscus*, and *Cyanocorax cayanus*.

4.8.11 Mammals

A total of 37 mammalian species from 20 families were reported by the 2006, 2007, and 2009 surveys. The methodologies used for the identification of mammals were VES, track and scat identification, mist netting for bats, and opportunistic sightings.

While the 2006/2007 surveys reported four or five species of primates, the 2009 surveys indicated only low numbers of howler (**Image 4.8-9**) and capuchin monkeys. In undisturbed regions of the Guianas with similar habitats, primate communities are generally more abundant and diverse.

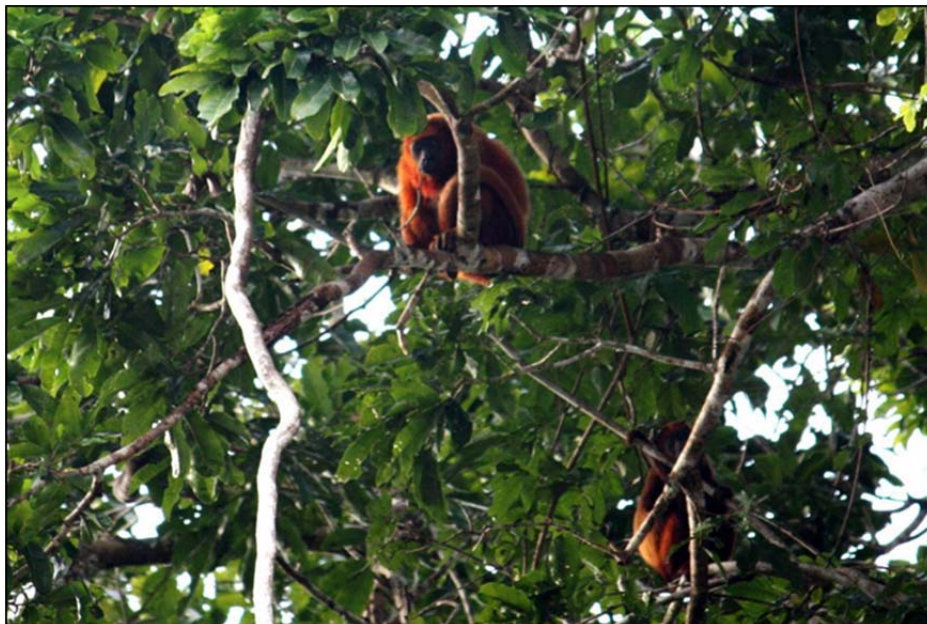


Image 4.8-9: Guiana red howler monkeys (*Alouatta macconnelli*) along Cuyuni River across from Aurora concession May 2009 Source: Langstroth, 2009

As mentioned above, a single giant otter (*Pteronura brasiliensis*) was observed swimming in the Cuyuni River in front of the Aurora concession in the May 2009 field surveys. An otter sighting was also reported in the 2006/2007 baseline surveys. No additional individuals or any other

⁵ The IUCN categories for the ornate hawk-eagle, the currasow and the ruddy pigeon changed during the course of the Project's biodiversity field studies (all were least concern in 2009).

dens were identified within the survey area. It is possible that the individual observed was a lone male that was passing through the area. None of the persons interviewed at the Aurora camp or the garimpeiro camp on Alligator Creek (outside of the Aurora concession) had observed giant otters in the project area. This otter is classified as an endangered species on the IUCN Red List. It was recommended that further studies be done to determine whether there were any resident populations within the project area, identify the location of any dens, estimate the population size, and assess potential impacts of the mining on this species, if present.

As also previously noted, internationally-recognized giant otter specialist Dr. Nicole Duplaix was retained to provide a field assessment for the giant otter in the Project AOI (Duplaix, 2009). The field assessment was performed October 13-22, 2009. No evidence for recent inhabitation by giant otters was found. Previous reports (2006/2007, 2009) are interpreted as transient males.

It is believed that the presence of ASM, hunting, and logging in the Project AOI has led to a reduction in the abundance of large mammals disturbance (see Duplaix, 2009) (**Appendix 4A**) for a more detailed discussion]. The presence of exploration activities in the Aurora concession has also likely led to the retreat of more sensitive species due to noise and activity (such as frequent use of ATVs on trails).

A total of 19 species of non-chiropteran mammals (i.e., other than bats) representing 11 families were recorded on the four Aurora transects during the 2011 surveys (**Table 4.8-11**). In 2010, 14 species were recorded in this area including 4 observed during the wet season survey. These included Neotropical otter (*Lutra longicauda*), giant otter (*Pteronura brasiliensis*), tamandua (*Tamandua tetradactyla*), and common porcupine (*Coendou prehensilis*). New species observed during the July 2011 survey included Guianan saki (*Pithecia pithecia*), bearded saki (*Chiropotes chiropotes*), common opossum (*Didelphis marsupialis*), tayra (*Eira barbara*), coati (*Nasua nasua*), and white-lipped peccary (*Tayassu pecari*). Species identification was based primarily on tracks observed in damp or wet areas along the primary transect lines, or up to 50 m on either side, as well as 25 m on either side of the secondary transect lines along which Sherman Traps were set. Sherman traps were unsuccessful in capturing small mammals in any of the secondary transects along which they were set. Tracks were limited to moist areas, areas with minimal leaf litter on the forest floor and termite mounds or ants nests. The most common animal tracks encountered were paca (*Cuniculus paca*), red acouchy (*Myoprocta acouchy*) and red-rumped agouti (*Dasyprocta leporina*), all of which are common in the area. The rarest occurrences were those of ocelot and jaguar.

Table 4.8-11. Non-chiropteran mammals observed during the 2011 surveys Opportunistic observations (Opp) are included separately.

Scientific Name	Common Name	Family	Aurora - Wet and Dry Season ¹				
			AA	PAS	TMA	CA	Opp
<i>Pithecia pithecia</i>	Guianan Saki	Pitheciidae	2				
<i>Alouatta macconnelli</i>	Red Howler Monkey	Atelidae	3	9	3	8	
<i>Cebus olivaceus</i>	Wedge-Capped or Weeper Capuchin	Cebidae		15			
<i>Saimiri sciureus</i>	South American Squirrel Monkey	Cebidae		15			
<i>Chiropotes satanas</i>	Bearded Saki	Pitheciidae				5	
<i>Mazama nemorivaga</i>	Amazonian Brown Brocket Deer	Cervidae		1	2	6	
<i>Mazama americana</i>	Red Brocket Deer	Cervidae	3	3	4	11	
<i>Dasyus novemcinctus</i>	Nine-Banded Long-nosed Armadillo	Dasypodidae		1	2	3	
<i>Cuniculus paca</i>	Paca/ Labba	Cuniculidae	1	1	7	15	
<i>Dasyprocta leporina</i>	Red-rumped Agouti	Dasyproctidae	2	2	5	14	
<i>Myoprocta acouchy</i>	Red Acouchy	Dasyproctidae	1		6	6	
<i>Didelphis marsupialis</i>	Common Opossum	Didelphidae			1	1	
<i>Panthera onca</i>	Jaguar	Felidae				4	
<i>Leopardus pardalis</i>	Ocelot	Felidae	2		1	2	
<i>Leopardus wiedii</i>	Margay	Felidae		1	1		
<i>Hydrochaeris hydrochaeris</i>	Capybara	Hydrochaeridae					5
<i>Eira barbara</i>	Tayra	Mustilidae	3				
<i>Oecomys bicolor</i>	Bicoloured Arboreal Rice Rat	Muridae			1		
<i>Tamandua tetradactyla</i>	Tamandua	Myrmecophagidae	1				
<i>Nasua nasua</i>	Coati	Procyonidae	1		1	1	
<i>Potos flavus</i>	Kinkajou	Procyonidae			1		
<i>Tapirus terrestris</i>	Lowland Tapir	Tapiridae	4	3		4	
<i>Tayassu pecari</i>	White-Lipped Peccary	Tayassuidae					
Total			23	51	35	80	5

¹. CA=Control Area; AA=Accommodation Area; TMA=Tailings Management Area; PAS=Permanent Airstrip; OPP=Opportunistic sightings off transect; area designations are based on early configuration of project features per (AMEC, 2009)]

The dry season survey yielded six species not observed during the July 2011 survey including wedge-capped capuchin (*Cebus olivaceus*), South American squirrel monkey (*Saimiri sciureus*), margay (*Leopardus wiedii*), bicoloured arboreal rice rat (*Oecomys bicolor*), tamandua (*Tamandua tetradactyla*), and kinkajou (*Potos flavus*).

The airstrip and TMA transects had greater numbers of species (9 and 10, respectively) during the dry season than during the wet season. Species numbers were lowest at the Aurora accommodation area. Several species recorded during the wet survey were not observed during the dry, including the bearded saki (*Chiropotes satanas*) and tayra (*Eira barbara*). The number of families represented did not vary greatly between the dry and wet season surveys.

During the wet season surveys, the greatest abundance and species richness of bats were recorded in the survey control area established at Aurora (**Table 4.8-12**). This finding may be due to the amount of relatively undisturbed habitat, presence of fruiting trees, and an open understory. The presence of *Vampyrum spectrum* in the control area is likely due to the close proximity of a seasonally inundated swamp, since these bats are often found foraging near swamps.

At the accommodation area, mist nets were set in locations where the understory was relatively open, and along an access road. Apart from the bats captured, many flying bats were also observed, and therefore identification was not possible. A few small creeks ran through the transect. These creeks are believed to be tributaries of Gold Creek and form a suitable habitat for many frog species which may have explained the presence of *Trachops cirrhosis*, the frog-eating bat.

No bats were captured in the nets at the TMA during the wet season, though bats were observed foraging and flying at this site. However, identification was not possible since there were no net captures.

During the dry season survey 45 bats representing 13 species and 3 families were identified (**Table 4.8-13**). Thirteen individuals representing 5 species were captured at the original TMA area, in contrast to the wet season survey, and 11 bats from 7 species were identified at the accommodation area. The original airstrip area had the lowest abundance and richness of the areas sampled, which could have largely been hampered by intense rainfall during the latter part of the sampling period.

Generally, the dry season survey results showed a higher degree of species richness and abundance than did the wet season survey.

Table 4.8-12: Bats captured during the 2011 wet and dry seasons at Aurora

Scientific Name	Common Name	Family	Aurora								Total
			Wet ¹				Dry				
			C A	A A	TM A	PA S	C A	A A	TM A	PA S	
<i>Carollia brevicauda</i>	Silky Short-tailed Bat	Phyllostomidae	4	2		1	3	3	3		16
<i>Carollia perspicillata</i>	Seba's Short-tailed Bat	Phyllostomidae	2				1				3
<i>Centronycteris maximiliani</i>	Shaggy Bat	Emballonuridae							1		1
<i>Desmodus rotundus</i>	Common Vampire Bat	Phyllostomidae						1			1
<i>Lophostoma brasiliensis</i>	Pygmy Round-eared Bat	Phyllostomidae					1	1	2		4
<i>Phylloderma stenops</i>	Pale-faced Bat	Phyllostomidae							2		2
<i>Phyllostomus hastatus</i>	Greater Spear-nosed Bat	Phyllostomidae	2				2	1	5	2	12
<i>Rhinophylla pumilio</i>	Dwarf Little Fruit Bat	Phyllostomidae	1	1			4	3		1	10
<i>Thyroptera tricolor</i>	Spix's Disk-winged Bat	Thyropteridae						1			1
<i>Trachops cirrhosus</i>	Fringe-lipped Bat	Phyllostomidae	2	1			2			1	6
<i>Lophostoma silvicolu</i>	White-throated Round-eared Bat	Phyllostomidae								3	3
<i>Vampyressa bidens</i>	Bidentate Yellow-eared Bat	Phyllostomidae					1				1
<i>Vampyressa thyone</i>	Northern Little Yellow-eared Bat	Phyllostomidae						1			1
<i>Vampyrum spectrum</i>	False Vampire Bat	Phyllostomidae	1								1
Total			12	4	0	1	14	11	13	7	62

¹. CA=Control Area; AA=Accommodation Area; TMA=Tailings Management Area; PAS=Permanent Airstrip; OPP=Opportunistic sightings off transect; area designations are based on early configuration of project features per (AMEC, 2009)]

4.8.12 Species Accumulation Curves

As noted above, multiple biodiversity surveys have been conducted at the Aurora site and vicinity since 2006. To examine the adequacy of the surveys in terms of relative numbers of new species per survey, cumulative species numbers versus survey years were plotted (see **Figures 4.8-3 and 4.8-4**). These curves indicate that the number of new species encountered in the survey is tailing off over the last several surveys, suggesting that the survey work has been adequate in terms of documenting the biodiversity of the study area.

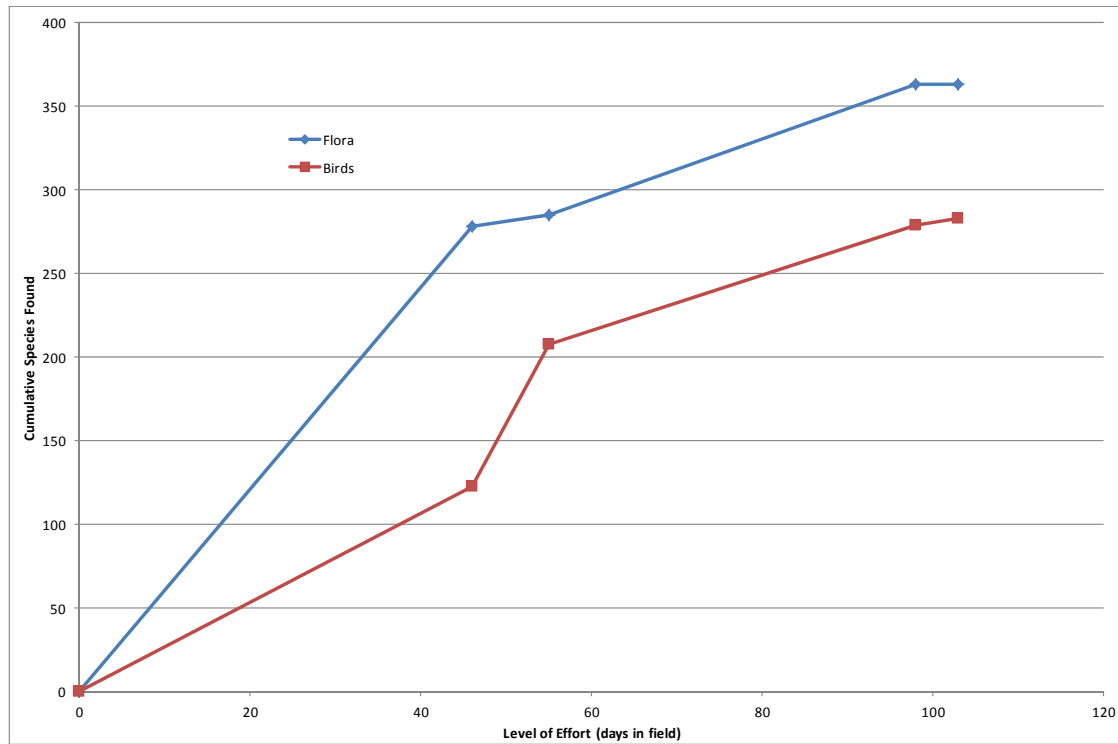


Figure 4.8-3. Number of New Species of Flora and Birds versus Sampling Years

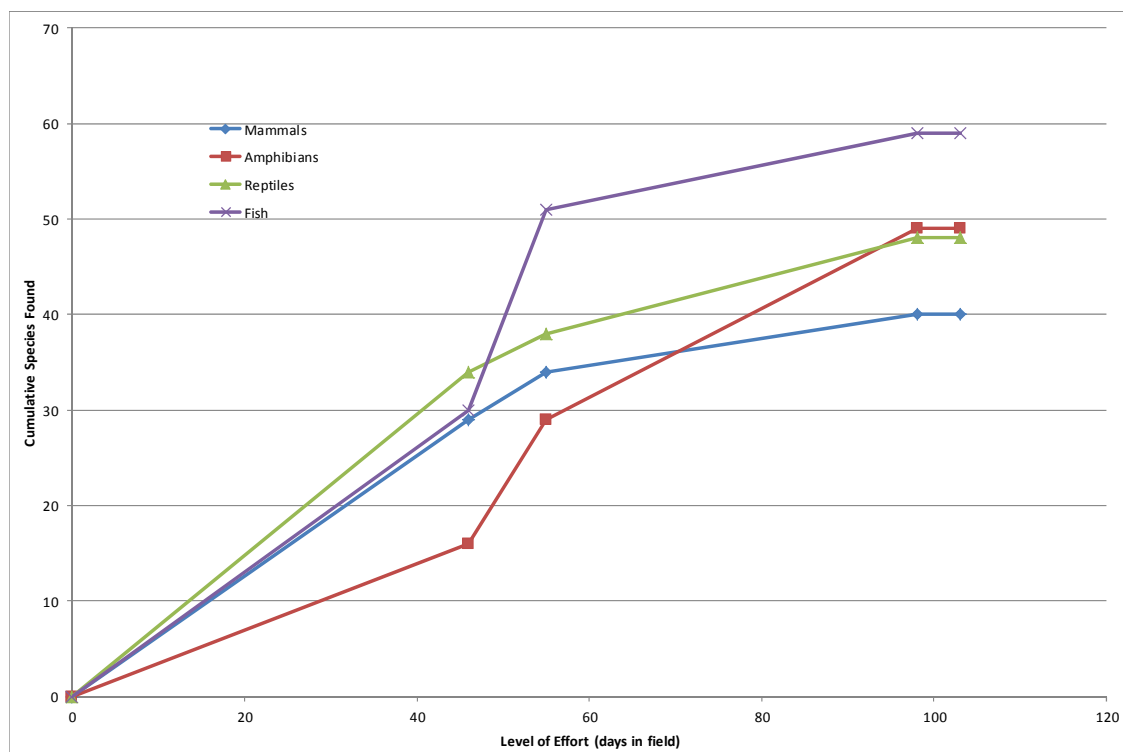


Figure 4.8-4. Number of New Species of Mammal, Amphibian, Reptile, and Fish versus Years of Survey

4.8.13 Invasive Alien Species

PS 6 (IFC, 2012b) stipulates that “Projects should not introduce or promote invasive alien species (plants or animals) except as may be allowed by governing regulations,” and that “existing alien species should not be spread; where practicable, they should be eradicated from natural habitats under the project proponent’s control.”

No alien species have been observed by the surveys in the Project AOI. Despite the opportunity that ongoing logging and small-scale mining operations have provided potentially invasive species, none appear to have dominated the local flora and fauna.

4.8.14 Critical Habitat Assessment

IFC PS 6 identifies six criteria for the assessment of whether a given modified or natural habitat may be considered a critical habitat:

- Criterion 1: Critically Endangered and Endangered Species;
- Criterion 2: Endemic and Restricted-Range Species;
- Criterion 3: Migratory and Congregatory Species;
- Criterion 4: Unique Assemblages of Species and Key Evolutionary Processes; and
- Criterion 5: Key Ecosystem Services.

These criteria were evaluated in the following sections.

4.8.14.1 Critically Endangered and Endangered Species

Guyana has no proposed or adopted list of threatened or endangered species. Therefore, the current IUCN Red List of Threatened Species (IUCN, 2012) was used in this analysis. The only endangered or critically endangered plant species listed by the IUCN for Guyana are:

- *Aniba rosaeodora* – EN;
- *Trichilia surumuensis* – EN;
- *Virola surinamensis* – EN; and
- *Vouacapoua americana* – CR.

Aniba rosaeodora, *Virola surinamensis*, and *Vouacapoua americana* are widespread species with hundreds or thousands of known localities. *Trichilia surumuensis* is restricted to the Roraima Highlands and is not likely to be present in the Aurora AOI. The populations in the Project AOI do not qualify the area as critical habitat since they do not constitute “regionally-important concentrations” and cannot be considered to be “of significant importance” where “the loss of such a habitat could potentially impact the long-term survivability of the species” as required by the Guidance Note to IFC PS 6 (IFC, 2012c).

Virola surinamensis is a widely distributed swamp and riverine forest species that is locally abundant in the Guianas (**Figure 4.8-5**). Known in Guyana as “swamp dalli,” it was reported as occurring in the project area in the October 2006 baseline data for the Aurora concession. There is no evidence to support a threatened status for populations of this species within the Guianas, and its presence should not be grounds for a critical habitat assessment given its widespread distribution and general abundance in swamp forests in the region.

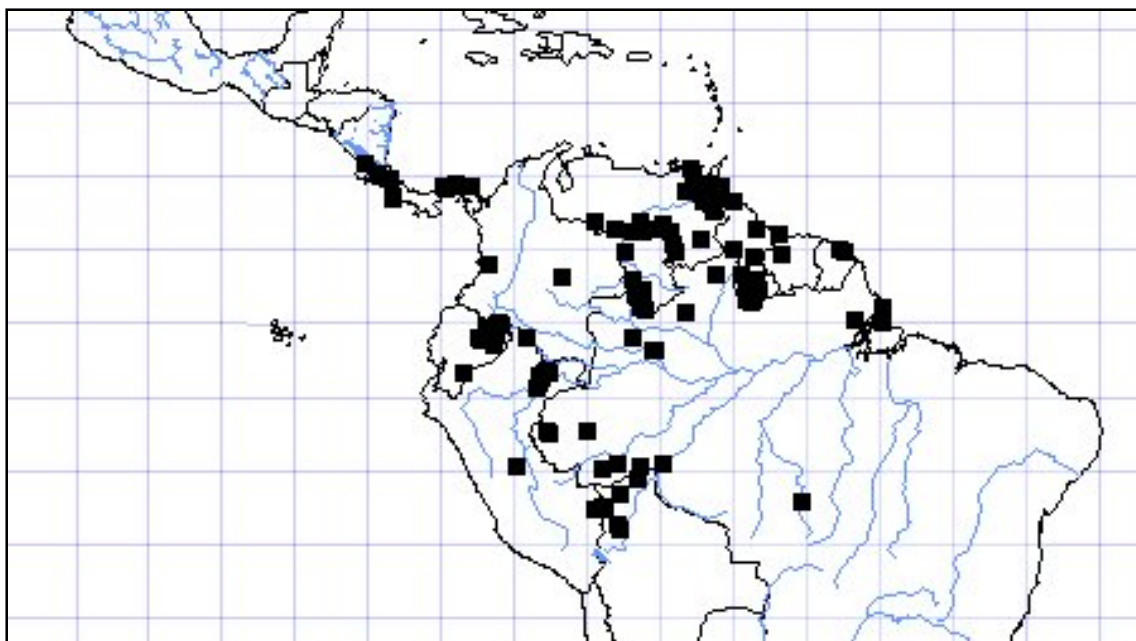


Figure 4.8-5. Distribution of Localities for Missouri Botanical Garden Specimens of *Virola surinamensis* for which Coordinates are Available Source:
http://mobot.mobot.org/cgi-bin/search_vast.

In addition, it should be noted that the Guidance Note for IFC PS 6 states that areas with “concentrations of vulnerable (VU) species in cases where there is uncertainty regarding the listing, and the actual status may be [endangered] EN or [critically endangered] CR” may qualify an area as critical habitat. However, such situations do not apply to either of the plant species listed as Vulnerable: *Couratari calycina* and *Couratari guianensis*. *Couratari* was believed to be endemic to Guyana and known from a single specimen collected along the Bartica-Potaro road when it was assessed by the World Conservation Monitoring Centre in 1998, which was the reason for its categorization as Vulnerable based on the criterion D2 of having “an acute restriction of its area of occupancy (typically less than 100 km) or in the number of locations (typically less than five).” However, this species is now known to occur in French Guiana as well (Funk et al., 2007) but its assessment has not been updated since 1998. *Couratari guianensis* is widespread in the Guianas, Amazonia, and Atlantic forests of Brazil, as well as Panama and Costa Rica. While this species has also not been reassessed since 1998, there is no evidence that the species is globally endangered or, in any case, that the Project AOI would qualify as having “regionally important concentrations” or be considered habitat of “significant importance” per the Guidance Note to IFC PS 6.

There are no endangered or critically endangered terrestrial or freshwater invertebrates listed by the IUCN for Guyana. The only fish and non-avian reptiles listed as endangered or critically endangered by the IUCN for Guyana are marine species that are not present in the Cuyuni and Mazaruni basins. No endangered or critically endangered amphibians are known to occur in Guyana and no Vulnerable species have been observed in the Project AOI. The yellow-footed tortoise is listed as Vulnerable by the IUCN and it should be noted that while the Guidance Note for IFC PS 6 notes that areas with “concentrations of vulnerable (VU) species in cases where there is uncertainty regarding the listing, and the actual status may be EN or CR” may qualify an area

as critical habitat, this does not apply to the yellow-footed tortoise. In a recent study on its role as an Amazonian seed disperser, Jerozolinski et al. (2009; see also references therein) state that the yellow-footed tortoise is of “wide geographical range” and of “relatively high abundance.”

According to BirdLife International, only three endangered bird species are known to occur in Guyana:

- Sun parakeet (*Aratinga solstitialis*);
- Hoary-throated spinetail (*Synallaxis kollari*); and
- Red siskin (*Carduelis cucullata*).

All of these birds are associated primarily with savanna or dry forest landscapes (i.e., Rupununi and Sipalawini savannas within Guyana), none of which is present in the Project area. The sun parakeet was reported by the 2006 field survey of the Aurora concession, but has not been reported since. The presence of resident or breeding populations is unlikely due to the absence of its preferred habitats. In any case, the Guidance Note to PS 6 does not recognize “vagrancies, marginal occurrence and historical records or unconfirmed anecdotal evidence” as regular occurrence of an Endangered species. While it does recognize “migratory species in transit,” the sun parakeet is not migratory.

As noted above, IUCN-listed ruddy pigeon species may qualify an area as critical habitat when there is uncertainty about the listing and the species may in fact be Endangered or Critically Endangered. Two Vulnerable birds were observed in the Project AOI: the black currawong and the ruddy pigeon. Both of these species were uplisted from Least Concern in the 2012 IUCN Red List from Near Threatened. Given the recentness of their assessments, there is little room for uncertainty.

The only other species of potential conservation interest are the harpy eagle and the ornate hawk-eagle, which are categorized as near threatened by the IUCN and have very large distributions in the tropical Americas. The home range size of these raptors is large (approximately 30 km² or greater), and the Aurora concession is not likely to support many individuals. Also, the observed primate population along the Cuyuni River and within the concession is low in comparison with similar habitats elsewhere in the Guianas (Duplaix, 2009)(see **Appendix 4A**), which suggests that the area is not a prime habitat for harpy eagles. While the IFC PS 6 allows the presence of Vulnerable species in certain cases to trigger critical habitat requirements, there is no mention of Near Threatened species in either PS 6 or its Guidance Note.

No Critically Endangered mammals are known to occur in Guyana. The only endangered mammal listed by the IUCN for Guyana is the giant otter (*Pteronura brasiliensis*). Individual giant otters were sighted on the Cuyuni River in the Project AOI during the 2006 and 2009 baseline studies, as previously noted. As a result of the 2009 sighting, a specialist survey was performed (Duplaix, 2009)(see **Appendix 4A**) to determine whether there was a permanent population of giant otters in the Project AOI or whether these sightings represent lone individuals passing through the area. This field survey did not reveal any signs of recent (i.e.,

within the previous four years) inhabitation by giant otters in the survey area, which included both the upstream and downstream portions of the Cuyuni River and the Julian Ross Itabu. As noted above, PS 6 does not recognize “vagrancies, marginal occurrence and historical records or unconfirmed anecdotal evidence” as regular occurrence of an Endangered species. While it does recognize “migratory species in transit,” the giant otter is not migratory.

The lowland tapir is listed as Vulnerable by the IUCN but there is no known uncertainty regarding the listing of this species and its actual status is not likely to be Endangered or Critically Endangered. While the Vulnerable Guiana spider monkey was reported by the 2006 surveys, it has not been observed subsequently and has likely been locally extirpated as it is a generally preferred food species by hunters.

4.8.14.2 Endemic and Restricted-Range Species

A preliminary list (Persaud, unpublished, cited by Ter Steege, 2000a) of Guyana's endemic flora included 284 species, approximately 5% of which are found in Guyana. Guyana as a geographic unit is no phytogeographic entity in itself but part of the Guiana Shield area and therefore any endemism is either caused by accident (restricted-range species) or if a habitat containing endemics is confined to Guyana (ter Steege, 2000a). In a regional context, species endemic to the three Guianas are especially abundant in the central and northwest region of Guyana (which includes the Cuyuni Basin), where they usually amount to more than 50% of all trees with a trunk diameter > 30 cm in the forest (ter Steege, 2000b). Species endemic to Guyana itself are more narrowly confined with maximum densities in an area surrounding the Potaro River basin and a small area to the east in the central highlands (ter Steege, 2000b).

Ter Steege (2000b) concludes that central and northwestern Guyana has a lower diversity but a higher proportion of typical Guianan taxa and endemics. The low diversity could be the result of a long standing process of low disturbance and, as such, is possibly unique to South America. Because central and northwest Guyana are the main timber concession areas, he urges that swift action be taken to preserve a portion of this important area.

The following list of 84 freshwater fish species considered endemic to Guyana is based on data in the March 2009 version of FishBase (www.fishbase.org), as compiled and published online by <http://Intreasures.com/guyanaff.html>, and updated according to Vari et al. (2009):

Table 4.8-13: Freshwater fish species considered endemic to Guyana			
Scientific Name	Common Name	Family	May Occur Elsewhere ¹
<i>Leporinus megalopsis</i>	Large-scaled Leporinus	Anostomidae	OC
<i>Bunocephalus chamaizelus</i>		Aspredinidae	
<i>Auchenipterus brevior</i>		Auchenipteridae	
<i>Centromochlus reticulatus</i>		Auchenipteridae	
<i>Tatia meesi</i>		Auchenipteridae	
<i>Trachelyichthys decaradiatus</i>	Guyanese Pigmy Driftwood	Auchenipteridae	
<i>Corydoras potaroensis</i>		Callichthyidae	

Table 4.8-13: Freshwater fish species considered endemic to Guyana

Scientific Name	Common Name	Family	May Occur Elsewhere ¹
<i>Cetopsidium roae</i>		Cetopsidae	
<i>Denticetopsis iwokrama</i>		Cetopsidae	
<i>Denticetopsis macilenta</i>		Cetopsidae	
<i>Acanthocharax microlepis</i>		Characidae	
<i>Aphyocharacidium melandetum</i>		Characidae	OC
<i>Aphyocharax erythrurus</i>	Flametail OC	Characidae	OC
<i>Aphyodite grammica</i>		Characidae	OC
<i>Astyanax mutator</i>		Characidae	OC
<i>Bryconamericus hyphesson</i>		Characidae	OC
<i>Deuterodon potaroensis</i>		Characidae	
<i>Hemigrammus cylindricus</i>		Characidae	OC
<i>Hemigrammus erythrozonus</i>	Glowlight Tetra	Characidae	
<i>Hemigrammus iota</i>		Characidae	
<i>Hyphessobrycon catableptus</i>		Characidae	
<i>Hyphessobrycon eos</i>		Characidae	
<i>Hyphessobrycon minimus</i>	Mini Tetra	Characidae	OC
<i>Hyphessobrycon minor</i>	White Minor	Characidae	OC
<i>Jupiaba essequibensis</i>		Characidae	OC
<i>Jupiaba mucronata</i>		Characidae	OC
<i>Jupiaba potaroensis</i>		Characidae	
<i>Microchemobrycon melanotus</i>		Characidae	
<i>Moenkhausia shideleri</i>		Characidae	OC
<i>Parapristella aubynei</i>		Characidae	
<i>Phenacogaster carteri</i>		Characidae	
<i>Phenacogaster megalostictus</i>	Large-spot Glass	Characidae	OC
<i>Aequidens potaroensis</i>	Guyana Aequidens	Cichlidae	OC
<i>Crenicichla wallacii</i>	Slender Pike Cichlid	Cichlidae	OC
<i>Mazarunia mazarunii</i>	Mazaruni Cichlid	Cichlidae	
<i>Ivanacara bimaculata</i>	Potaro River Dwarf Cichlid	Cichlidae	
<i>Ammocryptocharax lateralis</i>		Crenuchidae	OC
<i>Characidium pteroides</i>		Crenuchidae	OC
<i>Poecilocharax bovalii</i>		Crenuchidae	
<i>Skiocharax meizon</i>		Crenuchidae	
<i>Psectrogaster essequibensis</i>		Curimatidae	
<i>Rhinodoras armbrusteri</i>		Doradidae	
<i>Brachyglanis melas</i>		Heptapteridae	
<i>Brachyglanis phalacra</i>		Heptapteridae	
<i>Myoglanis potaroensis</i>		Heptapteridae	

Table 4.8-13: Freshwater fish species considered endemic to Guyana

Scientific Name	Common Name	Family	May Occur Elsewhere ¹
<i>Pimelodella altipinnis</i>		Heptapteridae	
<i>Pimelodella wessellii</i>		Heptapteridae	
<i>Rhamdella leptosoma</i>		Heptapteridae	
<i>Derhamia hoffmannorum</i>		Lebiasinidae	
<i>Nannostomus espeii</i>	Barred Pencilfish	Lebiasinidae	
<i>Nannostomus harrisoni</i>	Blackstripe Pencilfish	Lebiasinidae	OC
<i>Nannostomus minimus</i>	Least Pencilfish	Lebiasinidae	
<i>Ancistrus leucostictus</i>	Mana Ancistrus	Loricariidae	OC
<i>Ancistrus lithurgicus</i>		Loricariidae	
<i>Ancistrus nudiceps</i>		Loricariidae	
<i>Corymbophanes andersoni</i>		Loricariidae	
<i>Corymbophanes kaiei</i>		Loricariidae	
<i>Hypostomus hemiurus</i>		Loricariidae	
<i>Hypostomus macushi</i>		Loricariidae	
<i>Lasiancistrus schomburgkii</i>		Loricariidae	
<i>Lithogenes villosus</i>		Loricariidae	
<i>Lithoxus bovallii</i>		Loricariidae	OC
<i>Loricariichthys microdon</i>		Loricariidae	
<i>Parotocinclus collinsae</i>		Loricariidae	
<i>Peckoltia braueri</i>		Loricariidae	
<i>Peckoltia cavatica</i>		Loricariidae	
<i>Pseudacanthicus leopardus</i>	Orange-trim Sucker Catfish	Loricariidae	
<i>Pseudancistrus guentheri</i>		Loricariidae	
<i>Pseudancistrus nigrescens</i>		Loricariidae	
<i>Sturisoma monopenelte</i>		Loricariidae	
<i>Apareiodon agmatos</i>		Parodontidae	
<i>Cephalosilurus albomarginatus</i>	Bee Catfish	Pseudopimelodidae	OC
<i>Austrofundulus rupununi</i>		Rivulidae	
<i>Rivulus breviceps</i>	Shorthead Rivulus	Rivulidae	
<i>Rivulus holmiae</i>	Goldentail Rivulus	Rivulidae	OC
<i>Rivulus lanceolatus</i>		Rivulidae	
<i>Rivulus mahdiaensis</i>		Rivulidae	
<i>Rivulus mazaruni</i>	Mazaruni Rivulus	Rivulidae	
<i>Rivulus torrenticola</i>		Rivulidae	
<i>Rivulus waimacui</i>	Waimacui Rivulus	Rivulidae	
<i>Henonemus taxistigmus</i>		Trichomycteridae	OC
<i>Ituglanis gracilior</i>		Trichomycteridae	OC
<i>Ochmacanthus flabelliferus</i>		Trichomycteridae	OC

Table 4.8-13: Freshwater fish species considered endemic to Guyana			
Scientific Name	Common Name	Family	May Occur Elsewhere ¹
<i>Trichomycterus conradi</i>		Trichomycteridae	OC

¹.OC = a FishBase occurrence record suggests a specimen from another country outside normal stated range.

The majority of the above-listed species are found in the highlands of the Guiana Shield, especially in the Potaro River basin, or in the Rupununi Savannas region. While some species are known only from the Essequibo basin, none of these species are known to be endemic to the Cuyuni River basin.

Similar to the fish, the endemic amphibians of the Guianas are largely restricted to the Guiana Shield Highlands; however, there are some species known only from a few localities in the lowlands, or from the edge of the Shield Uplands (**Table 4.8-14**). No amphibian species are known to be endemic to the Cuyuni River basin.

The toad *Rhaebo nasicus* (**Image 4.8-10**) is endemic to western Guyana and the Bolívar State of Venezuela and is common at Aurora, although its known elevation range is stated as being from 500 to 1,350 masl (Hoogmoed and MacCulloch, 2004). With an estimated range of approximately 62,700 km² according to IUCN GIS data, it is not considered to have a restricted range. IUCN considers this species to be of Least Concern.



Image 4.8-10: *Rhaebo nasicus* toad at Aurora concession, May 2009.

The tree frog *Stefania evansi* (Least Concern per IUCN Red List) is presently recognized as endemic to Guyana and has an estimated range of 46,529 km² according to IUCN GIS data.

Figure 4.8-6 below shows the Aurora concession to be entirely outside of the estimated geographic range of the species as estimated by the IUCN; thus, the occurrence of this species in the area must represent either a “marginal occurrence” which is not recognized as triggering critical habitat requirements under PS 6 or a range extension that suggests that the actual range of the species may be greater (e.g., extending well up the Cuyuni basin) and exceed the 50,000 km² threshold for restricted-range species. In either case, the Project AOI is not likely to sustain more than 1% of the global population of the species, the threshold for qualifying as critical habitat for a restricted-range species. Presuming population is roughly equally distributed over the respective areas, the 58.02-km² Aurora concession would contain approximately 0.12% of the global population of the species.

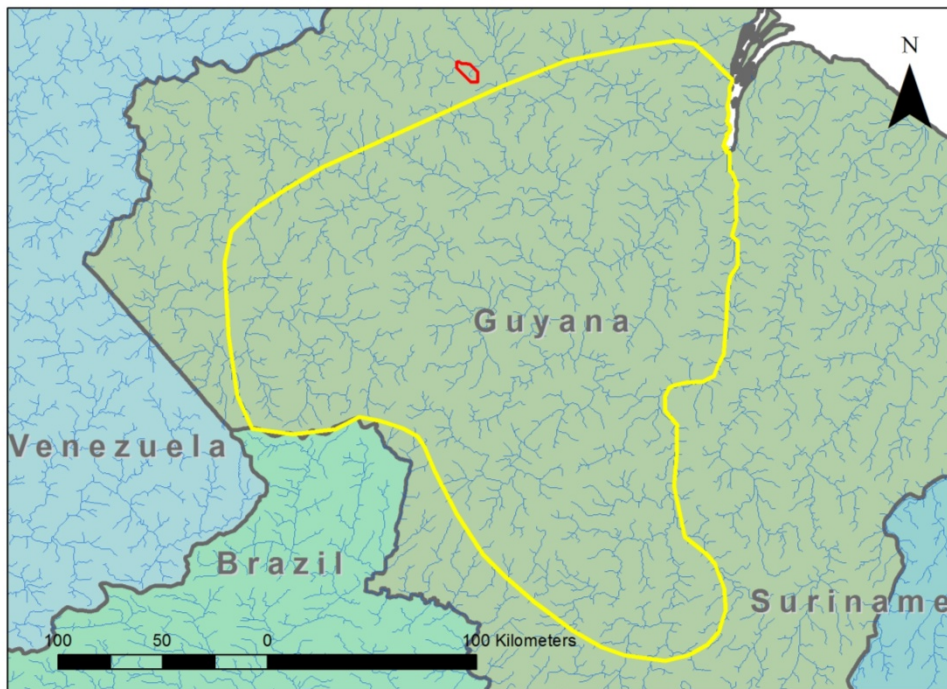


Figure 4.8-6. Estimated Range of *Stefania evansi* (yellow polygon) and Aurora Concession (red polygon).

Table 4.8-14: Amphibians endemic to lowland (<500 masl) Guyana, the Guianan Moist Forests Ecoregion (GMFE), or with restricted ranges (<50,000 km ²) that include the Lower Cuyuni-Mazaruni Basins (adapted from Frost, 2009; Señaris & MacCulloch, 2005; and http://Intreasures.com/guyanaa.html)			
Scientific Name	Distribution ²	GMFE Endemic	2012 IUCN Red List ¹
Anurans			
<i>"Hyla" helenae</i>	GU – Known only from type locality, "Valley of the Demerara River, Dunoon, British Guiana".	Yes	DD
<i>Allobates spumaponens</i> (Kok & Ernst, 2007)	GU – Known only from Mabura Hill Forest Reserve, Upper Demerara-Berbice Region, Guyana (5°09'N, 58°41'W, occurs at elevation of about 100 m.	Yes	DD
<i>Anomaloglossus kaiei</i> (Kok, Sambhu, Roopsind, Lenglet, and Bourne, 2006)	GU – Known from Kaieteur National Park and the Pakaraima Mountains, Guyana, where it is known to occur in primary and disturbed forest. Also found along the Guyana-Brazil border and possibly present in Brazil. It occurs at elevations between 150-900 m.	No	LC
<i>Anomaloglossus kaiei</i> (Kok, Sambhu, Roopsind, Lenglet, and Bourne, 2006)	GU – Known from Kaieteur National Park and the Pakaraima Mountains, Guyana, where it is known to occur in primary and disturbed forest. Also found along the Guyana-Brazil border and possibly present in Brazil. It occurs at elevations between 150-900 m.	No	LC
<i>Dendrobates nubeculosus</i> (Jungfer & Böhme, 2004)	GU – Known only from "Rockstone, Essequibo River, Mazaruni Potaro District, Guyana . . . Rockstone (4° 58' N, 58° 32' W), a town on the Essequibo River at 7 m above sea level"	Yes	DD
<i>Dendropsophus grandisonae</i> (Goin, 1966)	GU – Type locality: "in the forest at Mazaruni, British Guiana". Believed to be a lowland species (Frost, 2009)	Yes	DD
<i>Hypsiboas liliae</i> (Kok, 2006)	GU – Known from Kaieteur Plateau (5 10'51" N, 59, 28'57" W), 400 m elevation, and vicinity of Elinkwa River (5 10' 06" N, 59 23' 41" W), 550 m elevation, Kaieteur National Park. The species has been heard calling at the Guyana-Brazil border. It is believed to be widespread in the Pakaraima Mountains of Guyana at elevations between 400-1200 masl (Kok, 2008).	No	LC
<i>Leptodactylus lutzi</i> (Heyer, 1975)	GU – Type locality "Guyana, Chinapoon R., upper Potaro (probably Chenapown River)".	Yes	DD
<i>Pristimantis inguinalis</i> (Parker, 1940)	GU SU FG – Not in W. Guyana	Yes	LC
<i>Scinax proboscideus</i> (Brongersma, 1933)	GU SU FG - Endemic to the Guianas, 200–600 m – Not in Northern Guyana	Yes	LC

Table 4.8-14: Amphibians endemic to lowland (<500 masl) Guyana, the Guianan Moist Forests Ecoregion (GMFE), or with restricted ranges (<50,000 km²) that include the Lower Cuyuni-Mazaruni Basins (adapted from Frost, 2009; Señaris & MacCulloch, 2005; and http://Intreasures.com/guyanaa.html)			
Scientific Name	Distribution²	GMFE Endemic	2012 IUCN Red List¹
<i>Stefania evansi</i> (Boulenger, 1904)	GU - Endemic to Guyana, 20–890 m	No	LC
<i>Stefania woodleyi</i> (Rivero, 1968)	GU - Eastern portion of the Pakaraima Mountain region, Guyana, at elevations of 100-900 m.	No	LC
<i>Tepuihyla talbergae</i> (Duellman & Yoshpa, 1996)	GU – Known only from "Kaieteur Falls, 366 m (05° 10' N, 59° 28' W), Mazaruni-Potaro District, Guyana".	No	DD
<i>Trachycephalus hadrocephalus</i> (Duellman and Hoogmoed, 1992)	GU [SU] FG - Endemic to extreme southern Guyana and French Guiana, 50–500 m – NOT IN NORTHERN GUYANA	Yes	LC
Caeclians			
<i>Caecilia pressula</i> (Taylor, 1968)	GU - Known only from Marudi Mountains, Guyana (250 m)	No	DD
<i>Osaecilia zweifeli</i> (Taylor, 1968)	GU FG? - Type locality: "a small creek tributary to Río Mazaruni, British Guiana [= Guyana]".	Yes	DD
<i>Rhinatrema bivittatum</i> (Guérin-Méneville, 1829)	AP GU SU FG	Yes	LC

¹. DD- Data Deficient; LC=Least Concern; VU=Vulnerable

². Distribution codes: CG Colombian=Guayana; VA Venezuela – Amazonas; BO Venezuela – Boli'var; DA Venezuela – Delta Amacuro; BA Brazil – Amazonas; RO Brazil – Roraima; PA Brazil – Para; AP Brazil – Amapá; GU Guyana; SU Suriname; FG French Guiana.

As with other vertebrate groups, most of the endemic non-avian⁶ reptiles of Guyana are restricted to the highlands. The monotypic lizard genera *Kaieteurosaurus* and *Pantepuisaurus* are endemic to certain mountains of western Guyana, but these are not known from the lowlands of the GMFE. It should be noted that the state of knowledge regarding the squamate reptiles—lizards, amphisbaenids, and snakes—is far inferior to that of amphibians, birds, and mammals. No systematic assessments of their conservation status and distributions have been completed to date for South America, Amazonia, or the Guiana Shield region.

⁶ For purposes of scientific accuracy, the term "non-avian reptiles" to include the Testudines (turtles and tortoises), Crocodylia, and Squamata (lizards, snakes, amphisbaenia) is used here in recognition of the fact that birds are reptiles and represent the last living lineage of the dinosaurs.

Avila-Pires (2005) provided a list of the Guiana Shield reptiles which indicates the species considered as endemic (defined by that work as “when distribution is restricted to relatively small areas within the region”). The Guiana Shield region endemics known to occur in Guyana are listed in **Table 4.8-15**.

The Cuyuni-Mazaruni lowlands are not included in either of Guyana’s Endemic Bird Areas, i.e., the Rio Branco Gallery Forests in the Rupununi Savannas near the Brazilian border and the Tepuis in the Guiana Shield Highlands. While there are many bird species endemic to the Guiana Shield region, most of these are highland species and not endemic to the GMFE, as summarized in **Table 4.8-16**.

The only bird species identified as Guiana Shield endemics by Milensky et al. (2005) that may be considered endemic to the GMFE are *Picumnus minutissimus* and *Veniliornis sanguineus*. Neither of these two species is considered to be threatened under the 2012 IUCN Red List. These two species are shown by NatureServe (2007) to occur in the easternmost portion of the Cuyuni-Mazaruni District, but have not been reported within the Aurora concession.

Table 4.8-15: Non-avian reptiles endemic to the Guiana Shield Region and known to be present in Guyana (adapted and updated from Avila-Pires, 2005)

Scientific Name	Distribution ²	GMFE Endemic	2012 IUCN ¹ Red List
<i>Amphisbaena stejnegeri</i> (Ruthven, 1922)	GU – Known only from Demerara, Vreed en Rust (06°27'N, 58°19'W)	Yes	NE
<i>Arthrosaura guianensis</i> (MacCulloch & Lathrop, 2001)	GU – Mount Ayanganna, Pakaraima Mountains	No	NE
<i>Atractus favae</i> (Filippi, 1840)	GU SU	Yes?	NE
<i>Atractus tamessari</i> (Kok, 2006)	GU - Known only from along a tributary of Elinkwa River, ESE Kaieteur National Park, 500 m elevation, Potaro-Siparuni District	No	NE
<i>Dipsas pakaraima</i> (MacCulloch & Lathrop, 2004)	GU - NE plateau of Mt. Ayanganna 5°24' N, 59°57' W, 1490 m elevation, Guyana	No	NE
<i>Echinosauro sulcarostrum</i> (Donnelly, MacCulloch, Ugarte & Kizirian, 2006)	GU – Known only from Baramita, approximately 1 km S airstrip, 07°22'N, 060°29'W, elevation 100 m	Yes	NE
<i>Gonatodes alexandermendesii</i> (Cole & Kok, 2006)	GU – Known only from drainage system of the Konawaruk River, Kaieteur National Park, on the Potaro River. Type locality: Magdalen’s Creek Camp, near (275 m north) the northwest bank of the Konawaruk River (40 km [linear] WSW Mabura Hill), 120 m elevation, 5°13'07"N, 59°02'43"W	Yes?	NE
<i>Gymnophthalmus leucomystax</i> (Vanzolini &	RO GU – Rio Branco-Rupununi Savannas	No	NE

Table 4.8-15: Non-avian reptiles endemic to the Guiana Shield Region and known to be present in Guyana (adapted and updated from Avila-Pires, 2005)

Scientific Name	Distribution ²	GMFE Endemic	2012 IUCN ¹ Red List
Carvalho, 1991)			
<i>Gymnophthalmus vanzoi</i> (Carvalho, 1997)	RO GU – Rio Branco-Rupununi Savannas	No	DD
<i>Kaieurosaurus hindsii</i> (Kok, 2005)	GU – Edge of plateau 1,200 m north of Kaiteur Falls, 420 m elevation.	No	NE
<i>Pantepuisaurus rodriguesi</i> (Kok, 2009)	GU - Summit plateau of Mount Maringma, Cuyuni-Mazaruni District, Guyana (05° 12' 57"N, 060° 35' 07"W, 2,080 m).	No	NE
<i>Riolama leucosticta</i> (Boulenger, 1900)	RO GU - Highlands	No	NE

¹. NE = Not Evaluated.

². Distribution codes: CG Colombian Guayana; VA Venezuela – Amazonas; BO Venezuela – Bolívar; DA Venezuela – Delta Amacuro; BA Brazil – Amazonas; RO Brazil – Roraima; PA Brazil – Pará; AP Brazil – Amapá; GU Guyana; SU Suriname; FG French Guiana.

Table 4.8-16: Guiana Shield endemic birds (after Milensky et al., 2005)

Scientific Name	Common Name	Distribution ²	GMFE Endemic	2012 IUCN ¹ Red List
<i>Crypturellus ptaritepui</i> (Zimmer & Phelps, 1945)	Tepui Tinamou	BO	No	LC
<i>Penelope marail</i> (Muller, 1776)	Marail Guan	BO RO-BA PA-AP GU SU FG	No	LC
<i>Mitu tomentosum</i> (Spix, 1825)	Crestless Curassow	VA BO RO-BA GU – ALSO COLOMBIA	No	LC
<i>Crax alector</i> (Linnaeus, 1766)	Black Curassow	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Aratinga solstitialis</i> (Linnaeus, 1758)	Sun Parakeet	BO? RO-BA GU? SU FG	No	EN
<i>Pyrrhura egregia</i> (Sclater, 1881)	Fiery-shouldered Parakeet	BO RO-BA GU	No	LC
<i>Nannopsittaca panychlora</i> (Salvin & Godman, 1883)	Tepui Parrotlet	VA BO GU	No	LC
<i>Pionites melanocephalus</i> (Linnaeus, 1758)	Black-headed Parrot	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Gypopsitta caica</i> (Latham, 1790)	Caica Parrot	BO RO-BA PA-AP GU SU FG	No	LC

Table 4.8-16: Guiana Shield endemic birds (after Milensky et al., 2005)

Scientific Name	Common Name	Distribution ²	GMFE Endemic	2012 IUCN ¹ Red List
<i>Neomorphus rufipennis</i> (Gray, 1849)	Rufous-winged Ground-Cuckoo	VA BO RO-BA PA-AP GU	No	LC
<i>Caprimulgus whitelyi</i> (Salvin, 1885)	Roraiman Nightjar	VA BO RO-BA GU	No	LC
<i>Streptoprocne phelpsi</i> (Collins, 1972)	Tepui Swift	VA BO RO-BA GU	No	LC
<i>Campylopterus hyperythrus</i> (Cabanis, 1848)	Rufous-breasted Sabrewing	BO RO-BA GU	No	LC
<i>Campylopterus duidae</i> (Chapman, 1929)	Buff-breasted Sabrewing	VA BO RO-BA	No	LC
<i>Lophornis pavoninus</i> (Salvin & Godman, 1882)	Peacock Coquette	VA BO RO-BA GU	No	LC
<i>Polytmus milleri</i> (Chapman, 1929)	Tepui Goldenthrout	VA BO RO-BA GU	No	LC
<i>Heliodoxa xanthogonys</i> (Salvin & Godman, 1882)	Velvet-browed Brilliant	VA BO RO-BA GU	No	LC
<i>Galbula albirostris</i> (Latham, 1790)	Yellow-billed Jacamar	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Notharchus macrorhynchos</i> (J. F. Gmelin, 1788)	Guianan Puffbird	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Monasa atra</i> (Boddaert, 1783)	Black Nunbird	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Selenidera culik</i> (Wagler, 1827)	Guianan Toucanet	BO RO-BA PA-AP GU SU FG	No	LC
<i>Picumnus minutissimus</i> (Pallas, 1782)	Guianan Piculet	SU FG – ALSO GU (NatureServe)	Yes	LC
<i>Veniliornis sanguineus</i> (Lichtenstein, 1793)	Blood-colored Woodpecker	GU SU FG	Yes	LC
<i>Veniliornis cassini</i> (Malherbe, 1862)	Golden-collared Woodpecker	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Cranioleuca demissa</i> (Salvin & Godman, 1884)	Tepui Spinetail	VA BO RO-BA GU	No	LC
<i>Thripophaga cherriei</i> (Berlepsch & Hartert, 1902)	Orinoco Softtail	VA	No	VU
<i>Roraimia adusta</i> (Salvin & Godman, 1884)	Roraiman Barbtail	VA BO RO-BA GU	No	LC
<i>Frederickena viridis</i> (Vieillot, 1816)	Black-throated Antshrike	BO RO-BA PA-AP GU SU FG	No	LC
<i>Sakesphorus melanothorax</i> (Sclater,	Band-tailed Antshrike	PA-AP GU SU FG	No	LC

Table 4.8-16: Guiana Shield endemic birds (after Milensky et al., 2005)

Scientific Name	Common Name	Distribution ²	GMFE Endemic	2012 IUCN ¹ Red List
1857)				
<i>Thamnophilus insignis</i> Salvin & Godman, 1884	Streaked-backed Antshrike	VA BO RO-BA GU	No	LC
<i>Myrmotherula guttata</i> (Vieillot, 1825)	Rufous-bellied Antwren	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Myrmotherula gutturalis</i> (Sclater & Salvin, 1881)	Brown-bellied Antwren	BO RO-BA PA-AP GU SU FG	No	LC
<i>Herpsilochmus sticturus</i> (Salvin, 1885)	Spot-tailed Antwren	BO PA-AP GU SU FG	No	LC
<i>Herpsilochmus stictocephalus</i> (Todd, 1927)	Todd's Antwren	BO PA-AP GU SU FG	No	LC
<i>Herpsilochmus roraimae</i> (Hellmayr, 1903)	Roraiman Antwren	VA BO RO-BA GU	No	LC
<i>Cercomacra carbonaria</i> (Sclater & Salvin, 1873)	Rio Branco Antbird	RO-BA GU	No	NT
<i>Percnostola rufifrons</i> (J. F. Gmelin, 1789)	Black-headed Antbird	VA RO-BA PA-AP GU SU FG	No	LC
<i>Gymnopithys rufigula</i> (Boddaert, 1783)	Rufous-throated Antbird	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Myrmothera simplex</i> (Salvin & Godman, 1884)	Tepui Antpitta	VA BO RO-BA GU	No	LC
<i>Elaenia dayi</i> (Chapman, 1929)	Great Elaenia	VA BO	No	LC
<i>Phylloscartes nigrifrons</i> (Salvin & Godman, 1884)	Black-fronted Tyrannulet	VA BO RO-BA GU	No	LC
<i>Phylloscartes chapmani</i> (Gilliard, 1940)	Chapman's Bristle-Tyrant	VA BO RO-BA GU	No	LC
<i>Phylloscartes virescens</i> (Todd, 1925)	Olive-green Tyrannulet	RO-BA GU SU FG	No	LC
<i>Hemitriccus josephinae</i> (Chubb, 1914)	Boat-billed Tody-Tyrant	RO-BA PA-AP GU SU FG	No	LC
<i>Poecilatriccus russatus</i> (Salvin & Godman, 1884)	Ruddy Tody-Flycatcher	BO RO-BA GU	No	LC
<i>Todirostrum pictum</i> (Salvin, 1897)	Painted Tody-Flycatcher	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Pipreola whitelyi</i> Salvin & Godman, 1884)	Red-banded Fruiteater	BO GU	No	LC
<i>Lipaugus streptophorus</i> (Salvin & Godman, 1884)	Rose-collared Piha	BO RO-BA GU	No	LC
<i>Procnias albus</i> (Hermann, 1783)	White Bellbird	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Perissocephalus tricolor</i>	Capuchinbird	VA BO RO-BA PA-AP GU SU	No	LC

Table 4.8-16: Guiana Shield endemic birds (after Milensky et al., 2005)

Scientific Name	Common Name	Distribution ²	GMFE Endemic	2012 IUCN ¹ Red List
(Muller, 1776)		FG		
<i>Rupicola rupicola</i> (Linnaeus, 1766)	Guianan Cock-of-the-Rock	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Xenopipo uniformis</i> (Salvin & Godman, 1884)	Olive Manakin	VA BO RO-BA GU	No	LC
<i>Corapipo gutturalis</i> (Linnaeus, 1766)	White-throated Manakin	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Pipra cornuta</i> (Spix, 1825)	Scarlet-horned Manakin	VA BO RO-BA GU	No	LC
<i>Lepidothrix suavisissima</i> (Salvin & Godman 1882)	Orange-bellied Manakin	VA BO RO-BA GU	No	LC
<i>Lepidothrix serena</i> (Linnaeus 1766)	White-fronted Manakin	RO-BA PA-AP GU SU FG	No	LC
<i>Tyrannneutes virescens</i> (Pelzeln, 1868)	Tiny Tyrant-Manakin	BO RO-BA PA-AP GU SU FG	No	LC
<i>Neopelma chrysocephalum</i> (Pelzeln, 1868)	Saffron-crested Tyrant-Manakin	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Iodopleura fusca</i> (Vieillot, 1817)	Dusky Purpletuft	BO RO-BA GU SU FG	No	LC
<i>Hylophilus sclateri</i> (Salvin & Godman, 1883)	Tepui Greenlet	VA BO RO-BA GU	No	LC
<i>Troglodytes rufulus</i> (Cabanis, 1849)	Tepui Wren	VA BO RO-BA GU	No	LC
<i>Microcerculus ustulatus</i> Salvin & Godman, 1883	Fluting Wren	VA BO RO-BA GU	No	LC
<i>Microbates collaris</i> (Pelzeln, 1868)	Collared Gnatwren	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Cyanicterus cyanicterus</i> (Vieillot, 1819)	Blue-backed Tanager	BO RO-BA PA-AP GU SU FG	No	LC
<i>Diglossa major</i> (Cabanis, 1849)	Greater Flowerpiercer	BO RO-BA GU	No	LC
<i>Diglossa duidae</i> (Chapman, 1929)	Scaled Flowerpiercer	VA BO RO-BA	No	LC
<i>Mitrospingus oleagineus</i> (Salvin, 1886)	Olive-backed Tanager	BO RO-BA GU	No	LC
<i>Dolospingus fringilloides</i> (Pelzeln, 1870)	White-naped Seed eater	VA RO-BA PA-AP GU	No	LC
<i>Atlapetes personatus</i> (Cabanis, 1848)	Tepui Brush-Finch	VA BO RO-BA GU	No	LC
<i>Emberizoides duidae</i> (Chapman, 1929)	Duida Grass-Finch	VA	No	NT
<i>Myioborus</i>	Tepui Redstart	VA BO RO-BA GU	No	LC

Table 4.8-16: Guiana Shield endemic birds (after Milensky et al., 2005)

Scientific Name	Common Name	Distribution ²	GMFE Endemic	2012 IUCN ¹ Red List
<i>castaneocapillus</i> (Cabanis, 1849)				
<i>Myioborus cardonai</i> (Zimmer & Phelps, 1945)	Saffron-breasted Redstart	BO	No	NT
<i>Myioborus albifacies</i> Phelps & Phelps, 1946	White-faced Redstart	VA	No	LC
<i>Macroagelaius imthurni</i> (Sclater, 1881)	Golden-tufted Grackle	VA BO RO-BA GU	No	LC
<i>Euphonia finschi</i> Sclater & Salvin, 1877	Finsch's Euphonia	BO RO-BA GU SU FG	No	LC
<i>Euphonia cayennensis</i> (J. F. Gmelin, 1789)	Golden-sided Euphonia	BO RO-BA PA-AP GU SU FG	No	LC

¹ DD=Data Deficient; EN=Endangered; NT=Near threatened; VU=Vulnerable; LC=Least Concern

² Distribution codes: CG Colombian Guayana; VA Venezuela – Amazonas; BO Venezuela – Bolívar; DA Venezuela – Delta Amacuro; BA Brazil – Amazonas; RO Brazil – Roraima; PA Brazil – Para; AP Brazil – Amapá; GU Guyana; SU Suriname; FG French Guiana.

Of the Guiana Shield regional endemics listed above, the following species have been observed by the surveys in the Aurora Project AOI: *Cyanocorax cayanus*, *Perissocephalus tricolor*, *Pionites melanocephalus*, *Pionopsitta caica*, *Myrmeciza atrothorax*, *Myrmotherula gutturalis*, *Monasa atra*, *Crax alector*, and *Aratinga solstitialis*. None of these species qualify as restricted-range species under the definition of the IFC's Guidance Note on PS 6 (see **Table 4.8-10** above for distribution areas).

In their description of the GMFE, Schipper et al. (2012) state that the following mammal species are endemic to this ecoregion: *Marmosa lepida*, *Euphractus sexinctus*, *Saguinus midas*, *Pithecia pithecia*, *Ateles paniscus*, *Sciurillus pusillus*, *Oryzomys delicatus*, *Neacomys guianae*, *Sphiggurus insidiosus*, *Echimys chrysurus*, *Lophostoma schulzi*, and *Molossops neglectus*. However, based on the most recent distributional data from InfoNatura and the IUCN, none of these species should be considered endemic to the ecoregion (**Table 4.8-17**).

Table 4.8-17: Guiana Shield endemic mammals, after Lim et al. (2005)

Scientific Name	Distribution ²	GMFE Endemic	2012 IUCN ¹ Red List
<i>Didelphis imperfecta</i> (Mondolfi & Pérez-Hernández, 1984)	VA BO GU SU FG – also Brazil	No	LC
<i>Marmosa tyleriana</i> (Tate, 1931)	VA BO – Highlands	No	DD
<i>Monodelphis brevicaudata</i> (Erxleben, 1777)	VA BO GU SU FG – also Brazil	No	LC
<i>Monodelphis reigi</i> (Lew & Pérez-Hernández, 2004)	BO GU - Highlands	No	VU

Table 4.8-17: Guiana Shield endemic mammals, after Lim et al. (2005)

Scientific Name	Distribution ²	GMFE Endemic	2012 IUCN ¹ Red List
<i>Philander</i> sp. (Lew & Pérez-Hernández, ined.)	DA	No	NE
<i>Lonchorhina fernandezi</i> (Ochoa & Ibáñez, 1982)	VA BO – Lowlands	No	EN
<i>Lophostoma schulzi</i> (Genoways & Williams, 1980)	GU SU FG – also Brazil	No	LC
<i>Platyrrhinus aurarius</i> (Handley & Ferris, 1972)	VA BO GU SU – Highlands – also Brazil	No	LC
<i>Lasiurus atratus</i> (Handley, 1996)	BO GU SU FG - Lowlands	No	LC
<i>Molossus barnesi</i> (Thomas, 1905)	FG	Yes	DD
<i>Ateles paniscus</i> (Linnaeus, 1758)	GU SU FG – Lowlands - also Brazil	No	VU
<i>Pithecia pithecia</i> (Linnaeus, 1766)	VA BO DA GU SU FG – also Brazil	No	LC
<i>Sciurus flammifer</i> (Thomas, 1904)	BO - Lowlands	No	DD
<i>Neacomys dubosti</i> (Voss et al., 2001)	SU FG – Lowlands – also Brazil	No	LC
<i>Neacomys guianae</i> (Thomas, 1905)	VA BO GU SU – also Brazil	No	LC
<i>Neacomys paracou</i> Voss et al., 2001	BO GU SU FG – also Brazil	No	LC
<i>Neusticomys oyapocki</i> (Dubost & Petter, 1978)	FG – Lowlands – also Brazil	Yes	DD
<i>Oecomys auyantepui</i> (Tate, 1939)	BO GU SU FG – also Brazil	No	LC
<i>Oecomys rex</i> (Thomas, 1910)	BO GU SU? FG – also Brazil	No	LC
<i>Oecomys rutilus</i> (Anthony, 1921)	BO GU SU FG – also Brazil	No	LC
<i>Podoxymys roraimae</i> (Anthony, 1929)	BO GU – Highlands	No	VU
<i>Rhipidomys macconnelli</i> (de Winton, 1900)	VA BO GU – Highlands – also Brazil	No	LC
<i>Rhipidomys wetzeli</i> (Gardner, 1990; 1989)	VA BO GU - Highlands	No	LC
<i>Sphiggurus melanurus</i> (Wagner, 1842)	VA BO DA GU SU FG – also Brazil	No	LC
<i>Dasyprocta guamara</i> (Ojasti, 1972)	DA	No	NT
<i>Isothrix sinnamariensis</i> (Vié et al., 1996)	GU FG - Lowlands	Yes	LC
<i>Proechimys hoplomyoides</i> (Tate, 1939)	VA BO GU - Highlands – also Brazil	No	DD

¹ DD=Data Deficient; EN=Endangered; NT=Near threatened; VU=Vulnerable; LC=Least Concern

² Distribution codes: CG Colombian Guayana; VA Venezuela – Amazonas; BO Venezuela – Bolívar; DA Venezuela – Delta Amacuro; BA Brazil – Amazonas; RO Brazil – Roraima; PA Brazil – Para; AP Brazil – Amapá; GU Guyana; SU Surinam; FG French Guiana.

Marmosa lepida is primarily an Andean species, but has an apparently disjunct population in Suriname. *Euphractus sexicinctus* is found primarily in the open areas of central and southern South America, with only a small population in the savannas of Suriname. The primates *Ateles paniscus*, *Pithecia pithecia*, and *Saguinus midas* range from southern South America to the

north bank of the Amazon River in Brazil and cannot be considered endemic to this ecoregion. *Sciurillus pusillus* has a wide but disjunct range in Amazonian Peru, Colombia, and Brazil, as well as the Guianas. *Oryzomys delicatus*, if a valid species, is a savanna species and cannot be considered endemic to the GMFE. *Sphiggurus insidiosus* is found only in the Atlantic forests and Caatinga of eastern Brazil; however, *Sphiggurus melanurus* is endemic to the Guianan Shield, but not to the GMFE. *Echimys chrysurus* is also found in southern South America to the Amazon River and to the south of the river in Marajó Island, Para and Maranhão, Brazil. *Molossops neglectus* has a poorly known distribution, but has been documented from scattered sites in southern Brazil, Peru, Colombia, Venezuela, Guyana, and Suriname.

Of the above listed species, the following two are most nearly endemic to the GMFE: the rat *Neacomys guianae*, which also occurs in the Guianan Piedmont and Lowland Moist Forests Ecoregion of Venezuela and the bat *Lophostoma schulzi*, which also occurs in the Uatuma-Trombetas Moist Forests Ecoregion of northern Brazil. Neither of these two species has restricted ranges, and neither has been reported from the Project AOI.

Based on the distributions mapped by the IUCN and NatureServe, none of the three mammal species—*Molossus barnesi*, *Neusticomys oyapocki*, and *Isothrix sinnamariensis*—endemic to the GMFE are expected to occur in or near the Cuyuni and Mazaruni basins.

4.8.14.3 Migratory and Congregatory Species

While the Atlantic coastline of northwestern Guyana (i.e., Shell Beach) is an important area for nesting congregations of sea turtles, the interior lowlands of northern Guyana are not known to be critical habitats for any migratory or congregatory species. The Project AOI does not include any significant areas of open wetland habitats where congregatory species are known to assemble.

The Cuyuni River is a migration corridor for some fish species, including *Phractocephalus hemiliopterus*, *Prochilodus rubrotaeniatus*, *Pseudoplatystoma* sp., and *Sorubim elongatus*. One migratory species, *Astyanax bimaculatus* was recorded in 2011.

It is known that the Venezuelan portion of the Upper Cuyuni basin has been severely degraded in many areas due to mining activities that have released sediments and mercury into the river systems (Machado-Allison et al., 2000).

4.8.14.4 Highly Threatened and Unique Ecosystems

The terrestrial habitats of the Project AOI do not have any special significance as representatives of highly threatened ecosystems and are largely already affected by historic human activities in the region. Similar and higher-quality habitats are widespread in the Cuyuni basin. Therefore, they have low vulnerability and low replaceability. The watersheds to be affected by the project are small and all discharge into the Cuyuni River. Likewise, the ecosystems are not considered unique as they are neither of small spatial extent nor do they contain unique assemblages of species or concentrations of biome-restricted species. While the aquatic ecosystems of the Cuyuni basin are at significantly greater risk of decreasing in area or quality due to the impacts of artisanal and small scale mining, the aquatic habitats in the

Project AOI have already undergone degradation by activities unrelated to the Project and no longer present habitats of conservation value.

4.8.14.5 Key Evolutionary Processes

It is important to describe the landscape study area and the particular habitats in which the Project concession is located with respect to the following phenomena:

- transitional (ecotone) habitat or other landscape features of potential importance to speciation;
- unique assemblages of species associated with this altitude including those of very unique phylogeny;
- other landscape features of importance to evolutionary processes;
- wildlife corridors; and
- any other outstanding ecological features or functions of the landscape and/or the project concession site of critical importance to maintaining regional biodiversity.

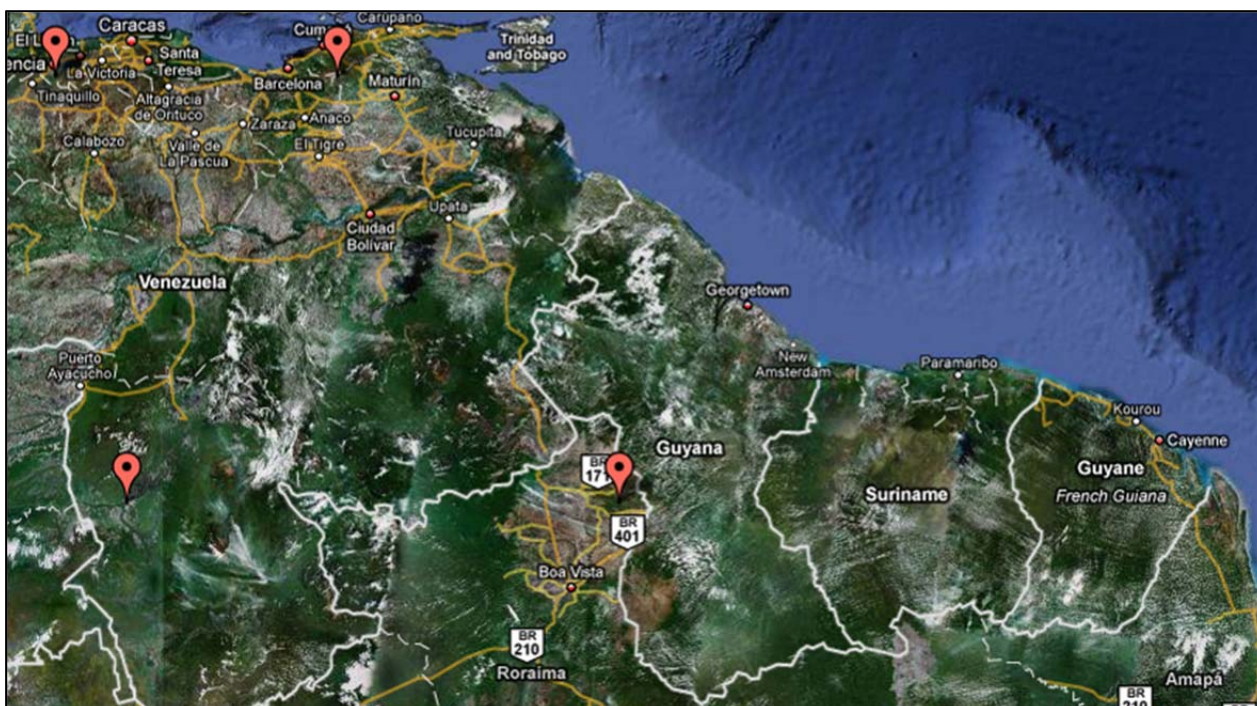
The habitats present in landscape containing the Project AOI are rather uniform and, as a result, there are no significant transitional habitats or ecotones that are of potential importance to speciation. This region of Guyana does not have pockets or belts of herbaceous wetlands, savannas, or dry forest formations. While there is some heterogeneity in the nature of the soils due to variations in geologic parent materials, such as granitic outcrops versus recent alluvium, these features are present across the regional landscape mosaic, and there are no known edaphically restricted plant assemblages or micro-endemic species in the region.

In contrast to the Guiana Shield Highlands that support unique assemblages of endemic species, especially above 1,500 m, the Aurora concession and the surrounding landscape are lowland ecosystems with elevations not exceeding 200 m and which are characterized by the dominance of widespread Guianan-Amazonian biota.

There are no recognized unique assemblages or species of unique phylogeny associated with the landscape of the Aurora concession. This absence of unique assemblages and lineages reflects the absence of isolated landscape features of importance to evolutionary processes, such as caves, plateaus, springs, barrens, or lagoons, as well as the absence of major barriers to dispersal such as high mountain ranges, expansive open vegetation formations, or larger rivers.

The Cuyuni River itself is an important ecological and biogeographic corridor for aquatic and riverine terrestrial biota, linking the eastern Venezuelan Guayana highlands with the lower Essequibo Basin, as well with Amazonia via the Rupununi flood savannas mixing zone. Guyana is unique among the three Guianan countries for the presence of numerous Amazonian fishes absent from Suriname and French Guiana, such as the giant *Arapaima gigas*.

There are no outstanding terrestrial ecological features or functions of the landscape and/or the Project concession site of critical importance to maintaining regional biodiversity. The ecological features and functions of the Aurora concession and the surrounding area are



replicated across the Cuyuni and Mazaruni lowlands and the rest of the Guianan Lowland Moist Forests ecoregion.

4.8.15 Legally Protected and Internationally Recognized Areas

A 2005 Global Environment Facility proposal for the Guyana Protected Areas System Project Phase I identifies the Upper Cuyuni River as an area of conservation interest. This area was characterized as relatively unexplored with many species from the Guiana Shield area. According to the proposal, recent expeditions gave evidence of a unique flora that was very poorly studied and a completely unsampled fauna. This area contains the headwaters of the Cuyuni River. The proposal also noted that there was considerable mining in this area. Based on the characterization of the area, this area does not include the Guyana Goldfields AOI, which is centered on the lower Cuyuni and does not include the headwaters in the Guiana Shield highlands. No High Conservation Value areas, Alliance for Zero Extinction sites, IBAs, Key Biodiversity Areas, or Important Plant Areas have been identified within Guyana to date (Figures 4.8-7 and 4.8-8).

Figure 4.8-7: Alliance for Zero Extinction Sites in the Guiana Shield Region. Note: The Rio Tacutu site in Brazil near the Guyana border is a savanna ecosystem designated for the endangered hoary-throated spinetail (bird). Source: Downloaded from <http://www.zeroextinction.org/sitemap.htm>. 18 August 2009.



Figure 4.8-8: Alliance for Zero Extinction Sites in Northern South America, Mesoamerica, and the Caribbean. Note the paucity of sites in the Amazonian and Guianas regions in contrast with the Andes. Source: Downloaded from <http://www.zeroextinction.org/sitemap.htm>. 18 August 2009.

No nongovernment organizations (NGOs) or governmental institutions have identified any area within the concession itself as a priority for conservation interest. The conservation initiatives in Guyana are largely focused on the larger forested landscapes of central and southern Guyana or in the Rupununi Savannas region. Likewise, there are no established or proposed protected areas of any category in the AOI (**Figure 4.8-9**)

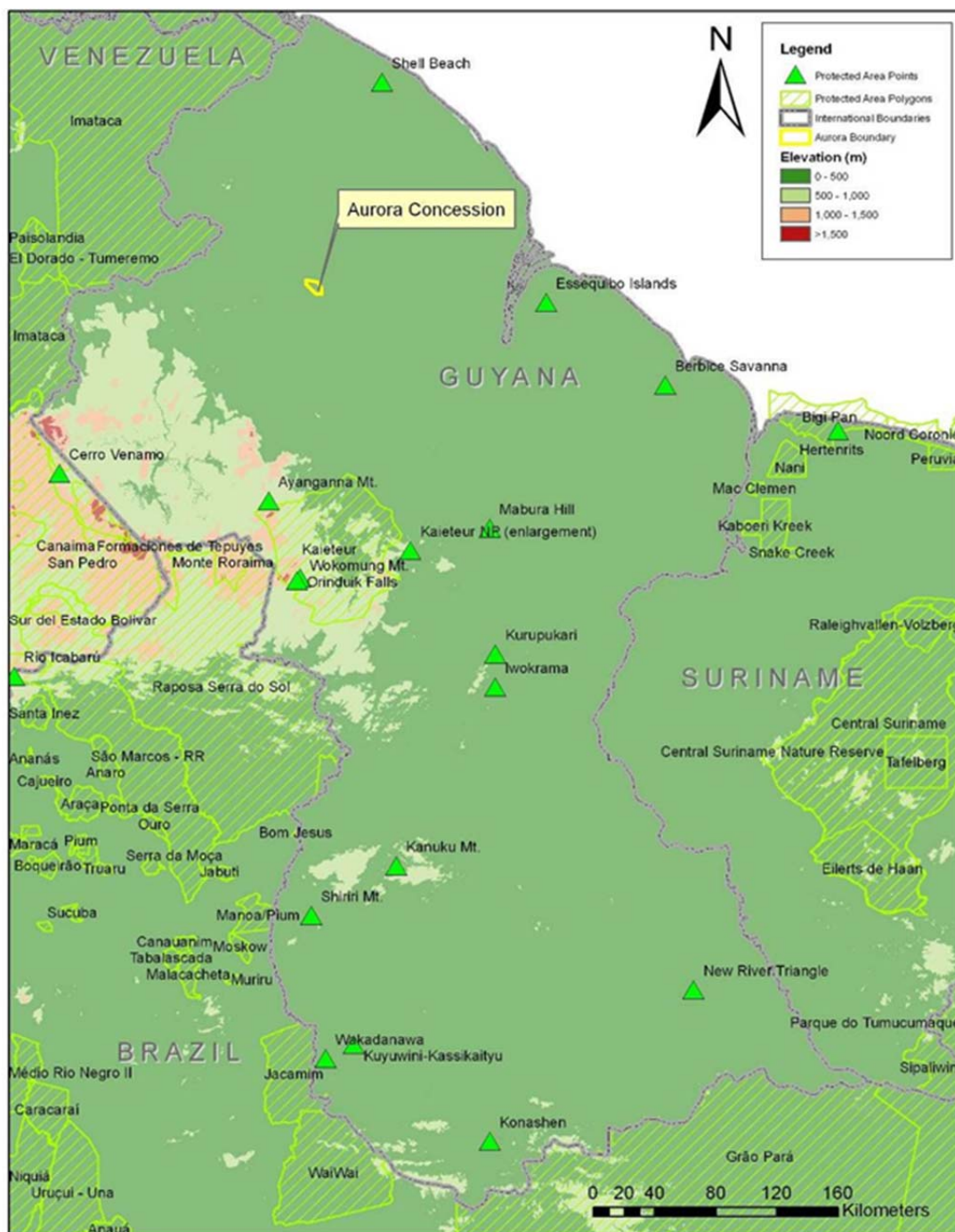


Figure 4.8-9: Protected Areas in Guyana and Adjacent Areas Source: Data from 2009 World Database of Protected Areas

4.8.16 Ecosystem Services

IFC PS 6 (IFC, 2012b) adopts the Millennium Ecosystem Services⁷ definitions. However, in the 2012 Guidance Notes for PS 6, client requirements for assessing and managing ecosystem services are deemed to be applicable only when the client has direct management control or significant influence over such services. Therefore, PS 6 does not address ecosystem services whose beneficiaries are at global and sometimes regional scales.

IFC further divides ecosystem services into two categories:

- **Type I:** Provisioning, regulating, cultural and supporting ecosystem services, over which the client has direct management control or significant influence, and where impacts on such services may adversely affect communities.
- **Type II:** Provisioning, regulating, cultural and supporting ecosystem services, over which the client has direct management control or significant influence, and on which the project directly depends for its operations.

Given these observations and the environmental and social setting of the Aurora Project, there are no ecosystem services over which the Project can be said to have direct control. Further, regarding Type I services, there are no communities utilizing ecosystem services on which the Project will have adverse effects. With respect to Type II services, there are no ecosystem services the Project is likely to affect upon which the Project is dependent.

⁷ See <http://www.millenniumassessment.org/en/index.html>

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Section 5: Socioeconomic Baseline

Contents

	Page
5 Socioeconomic Baseline	5-1
5.1 Introduction and Methodology	5-1
5.2 National Context	5-2
5.3 Regional Context	5-2
5.4 Social Area of Influence	5-3
5.5 Communities Studied in the Baseline	5-5
5.5.1 Communities in the DAI	5-5
5.5.2 Detailed Baseline for Communities in the Project's DAI	5-6
5.5.3 Communities in the Project's IAI	5-20
5.5.4 Other Project Beneficiaries	5-22
5.5.5 Summary of Findings	5-24
References	5-27

List of Figures

- Figure 5.4-1: Location of Communities within the Social Area of Influence
 Figure 5.5-1: Location of Other Project Beneficiaries

List of Tables

- Table 5.4-1: Communities within the Social Area of Influence
 Table 5.5-1: Approximate Number of Adult Males, Adult Females, and Children Living in Aranka Mouth
 Table 5.5-2: Approximate Age Breakdown of Aranka Mouth Residents
 Table 5.5-3: Approximate Number of Adult Males, Adult Females, and Children Living in Buckhall
 Table 5.5-4: Approximate Age Breakdown of Buckhall Residents

List of Appendices

- Appendix 5A: Example of Questionnaire Used for Gathering Updated Social Baseline Data
 Appendix 5B: Public Meeting Notices and Posters for Interviews with Aranka Mouth and Buckhall Communities

5 Socioeconomic Baseline

5.1 Introduction and Methodology

This socioeconomic baseline discussion is based on information originally presented in the *Final [sic] Environmental and Social Impact Assessment (ESIA) of the Aurora Mine Project in Guyana* (ERM, 2010), referred to hereafter as the Environmental Resource Management (ERM) ESIA, as well as information gained in additional public consultations and new data for the Area of Influence (AOI) of the Aurora Gold Project (Project) that were gathered in 2011 and 2012. It should be noted that the results of the most recent governmental census for Guyana (2007) have never been publicly released, so the most current publicly available census data are from 2002. These data were originally included in the ERM ESIA.

At the time of the original baseline study for the ERM ESIA, there were no formal or established communities or settlements in the immediate vicinity of the Project site, and there were very few communities in proximity to existing or planned Project facilities. All six communities studied for the ERM ESIA were considered to be in the Project's Indirect Area of Influence (IAI), and included settlements and small villages: Aranka, Bartica, Itaballi, Kurutuku, Buckhall, and Parika. As a result of this updated baseline study, the Project's defined Direct Area of Influence (DAI) has been modified as follows:

- **Itaballi**, located approximately 9.5 kilometers (km) from Bartica on the west bank of the Mazaruni River, is no longer included in the Project's IAI. In Itaballi, Guyana Goldfields, Inc. (GGI) formerly maintained a small facility that was used as a security post and provided temporary living accommodations for workers traveling to and from the interior. This facility was used by Project personnel traveling to and from the Project site until 2009, when the Buckhall port and camp was established. Buckhall is now GGI's only point of entry to the interior for the Project.
- **Buckhall**, a community previously within the Project IAI, has been reassigned to the Project DAI due to its proximity to GGI's port and logistics facility of the same name.
- **Aranka Mouth** is an informal settlement 16 km downriver from the Project site, and it has been added to the DAI.

Additional details on these latter two communities are included in Section 5.5.1.

The new social and socioeconomic information presented in this report was collected in January 2011 via site visits to communities, scheduled public meetings and consultations, and focused semistructured interviews. To facilitate the gathering of socioeconomic baseline data and to ensure consistency, a questionnaire was developed and used during individual and group interviews with community members, and interviewees' responses to questions were crosschecked. An example of the questionnaire is presented in **Appendix 5A**; public notices and posters presented in support of these information-gathering sessions are included in **Appendix 5B**.

In the week following the public consultations, additional engagement with Aranka Mouth and Buckhall took place using the questionnaires. The findings from this exercise are incorporated in Section 5.5 below.

5.2 National Context

Guyana is the third smallest country in South America and the third poorest country in the Latin America and Caribbean Region. The country has one of the world's highest forest cover per capita ratios as 80% of the country is covered by forest. However, 90% of the population lives in the narrow coastal plain strip, much of which is below sea level and has been cleared of forest for agriculture since colonial times.¹

There is significant variation in the sources of readily available demographic and economic statistics for Guyana. For example, the 2002 Guyana census population provided by the Guyana Bureau of Statistics web site is defined as 751,223,² whereas the CIA World Fact Book for Guyana provides a July 2012 population estimate of 741,908.³ Gross domestic product (GDP) numbers also vary by source.

The United Nation (UN) Human Development Index (HDI) ranks Guyana 117th out of 187 countries, with a score of 0.633 as of 2011.⁴ The HDI uses a composite measure of three basic dimensions of human development: health, education, and income. The average HDI of the Latin America and the Caribbean region increased from 0.582 in 1980 to 0.731 as of 2011, placing Guyana below the regional average.

Guyana's real GDP for 2011 was estimated to be US\$ 5.875 billion and was projected to grow 4.2% in 2011. The economy is heavily dependent upon the export of six commodities: sugar, gold, bauxite, shrimp, timber, and rice. These six commodities represent nearly 60% of the country's GDP. Foreign direct investment in Guyana as a percentage of GDP (2009) was 7.1%.⁵

Despite overall economic growth trends, it was estimated in 2005 that 7.3% of the population lived below the national poverty level.⁶ Inward remittances are an important component of the Guyanese economy, contributing roughly US\$316 per capita and totaled nearly US\$253 million in 2009. The high rate of inward remittances, representing 17.3% of GDP, ranked Guyana as the 9th highest recipient of remittances in the world in 2009 and reflects the high emigration rates of Guyanese to work in other countries. Guyana is ranked 5th in the world for emigration (56.8% of its total population and 89% of its tertiary-educated population as of 2010) with the majority of migrants residing in North America.⁷

5.3 Regional Context

The Project is located in Region 7 of Guyana's 10 administrative regions. Region 7—commonly referred to as the Cuyuni-Mazuruni region—is the second largest in area, comprising some 47,213 square kilometers. The population of Region 7 was estimated to be 17,597 in the 2002

¹ <http://www.worldbank.org/en/country/guyana/overview>

² <http://www.statisticsguyana.gov.gy/census.html>

³ <https://www.cia.gov/library/publications/the-world-factbook/geos/gy.html>

⁴ "Human Development Report 2011 – Sustainability and Equity: A Better Future for All" (UNDP, 2011)

⁵ *ibid.*

⁶ "World Bank Migration and Remittances Factbook 2011" (World Bank, 2011)

⁷ *ibid.*

census, giving an average population density of 0.37 persons per square kilometer. Most of the population (7,423) is concentrated in Bartica, the capital of Region 7.⁸

With the exception of Bartica, there are no formally incorporated towns or villages in Region 7. Region 7 has few roads other than the timber haul roads developed by Barama Company Limited (Barama). The rivers remain the primary means of access and transportation to and from the interior of Region 7. In general, the area is largely unsettled, and very few governmental services are provided to the population. While there are a number of Amerindian communities in Region 7, there are none in the immediate vicinity of the Aurora site. Kurutuku, the Amerindian community closest to the Project, is approximately 40 km west-northwest up the Cuyuni River, near the border with Venezuela.

In the vicinity of the Aurora site, the dominant population consists of small-scale gold miners and the associated service community which has developed in proximity to the main mining areas. The social fabric of the region is dynamic and has been changing rapidly in recent years as the price of gold has increased.

Artisanal and small-scale mining (ASM)⁹ has reportedly been an important economic activity in Region 7 for a century or more, but the ASM population was not included in the government's 2002 census, and no reliable data are available to document their numbers. Additionally, much of the gold is sold through the black market, therefore, there are no reliable statistics on the economic value of ASM. Tracking the populations of miners and the amount of gold taken and sold would be extremely difficult due to the remoteness of the area and the influence that the price of gold exerts on the numbers of individuals engaged in mining. While the mining camps are largely temporary and mobile, some miners use heavy equipment (e.g., dozers and backhoes). As they are mining alluvial deposits rather than undertaking hard rock mining, the populations are concentrated along tributaries to the Cuyuni (e.g., Aranka Creek, some 14 km from the Project). With the consistently high price of gold in recent years, there has been a significant increase in the numbers of miners, and the areas of impact have visibly increased, based on aerial observations. Guyana may be said to be experiencing an extended "gold rush." The high price of gold has given residents of coastal areas ("coastlanders") and Brazilian and other foreign nationals incentive to migrate to areas rich in alluvial gold (e.g., Aranka Creek) in search of economic opportunity, either on a temporary or permanent basis. Region 7 has a limited government presence and is essentially a frontier zone dominated by miners, a number of whom are illegal aliens from Brazil and other neighboring countries.

5.4 Social Area of Influence

The Project social AOI is defined as three consecutively larger areas:

- The first area is a DAI encompassing the Project area and a 1-km wide corridor centered on the access road from the Project site across the Cuyuni River to the Barama Road and east to the Project's Buckhall logistics and port facility. There are no villages or other occupied areas in the immediate vicinity of the Aurora site as the area is for the most part

⁸ Bureau of Statistics Guyana: Population & Housing Census 2002 - Final Summary Results, Oct. 2005

⁹ "Artisanal" is a misnomer in this case as the miners use heavy equipment and can impact large areas rapidly.

uninhabited with the exception of shifting artisanal miner communities. There are no incorporated communities located within the DAI.

- The second area is a broader IAI that takes into consideration potential interactions or impacts on communities, settlements, and ASM encampments geographically removed or isolated from the Project and its components.
- The third area is the Nation of Guyana as a whole; while the Project is located in an isolated area in northwestern Guyana, its magnitude and size is likely to positively impact the overall socioeconomic status of the country until the end of the Project's operational phase. The Project has the potential to provide significant employment and be a driver for economic growth in the country, as well as employ an existing local skilled work force. In the longer term, there are potential economic and employment impacts related to Project decommissioning which may also affect the nation as a whole.¹⁰

Table 5.4-1 lists the communities within the social AOI, their regional associations, and the nature of their individual AOIs. A map showing the community locations is provided in **Figure 5.4-1**.

Table 5.4-1. Communities within the Social Area of Influence

Community	Region	Area of Influence
Aranka Mouth	7	Direct
Buckhall	3	Direct
Aranka	7	Indirect
Parika	3	Indirect
Bartica	7	Indirect
Kurutuku	7	Indirect

¹⁰ Definition based on ERM ESIA

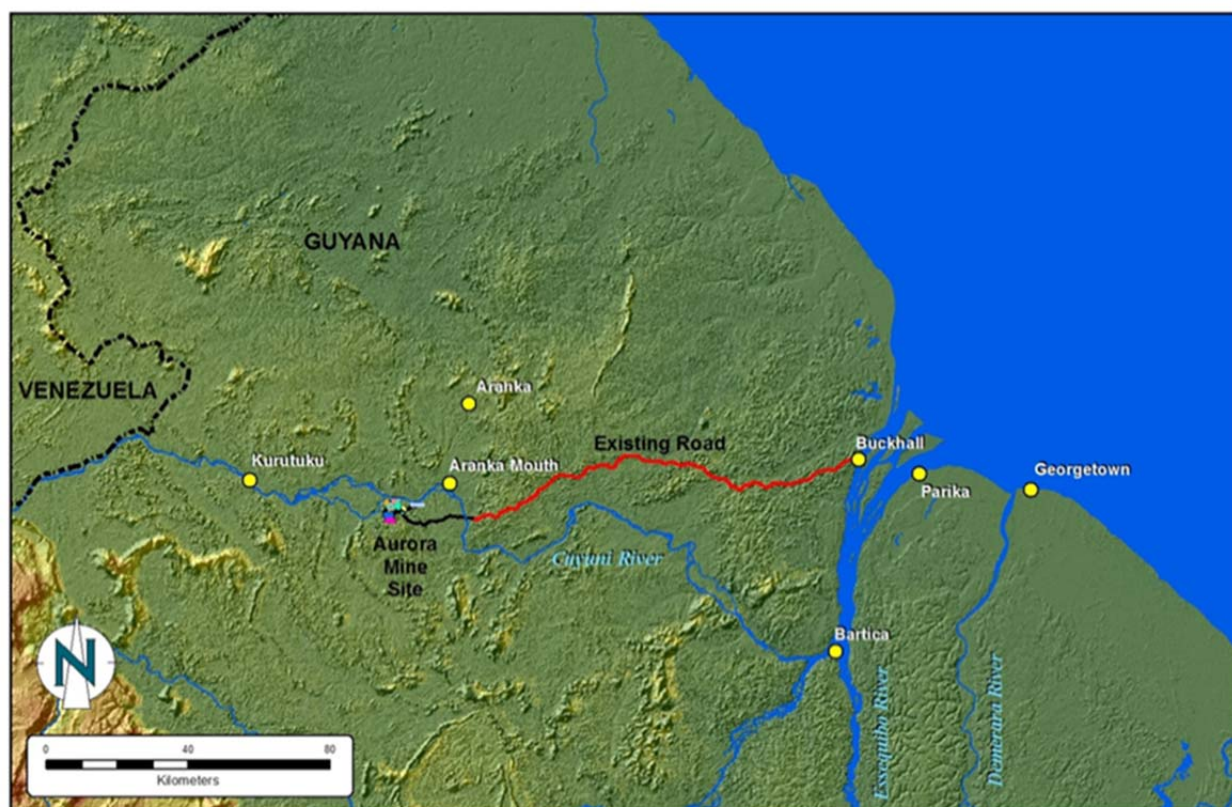


Figure 5.4-1. Location of Communities within the Social Area of Influence

Based on observations made by ENVIRON staff during multiple trips to the Project area in 2010 and 2011, there are no established villages, communities, settlements, or individual households along the Barama Road or the access road to the Cuyuni River and on to Aurora. At various locations along the Barama Road, beyond 70 km and 112 km, Barama operates checkpoints and satellite camps that are used to house equipment and logging personnel. These satellite camps are the only structures along the road; they are manned by Barama employees who monitor road conditions, and at times of heavy rainfall, place barriers on the road, thereby closing it to traffic. The Barama Road between Buckhall and Tapir is considered to lie within the Project DAI.

5.5 Communities Studied in the Baseline

5.5.1 Communities in the DAI

The main focus of this discussion is on the two communities that have been identified to be within the Project's DAI: Aranka Mouth and Buckhall.

Aranka Mouth is a small, transient unincorporated riverside settlement located on the south bank of the Cuyuni opposite the mouth of Aranka Creek. The distance from Aranka Mouth to the Project site is approximately 14 km in a straight line and a 16 km journey by boat along Cuyuni River. Aranka Mouth was not included in the social baseline study for the ERM ESIA, but it is included in the DAI for this ESIA, as it is presently the settlement closest to the Project site.

Buckhall is a small, transient, unincorporated riverside community of 150–200 inhabitants located on the west bank of the Essequibo River in Administrative Region 3 and is immediately adjacent to the GGI Buckhall port and logistics support camp. Buckhall is approximately 179 km east of the Project site by road; travel time is 4 to 6 hours by road from Buckhall to Tapir Crossing and then an additional 1 hour on to the Project site by river or by road. Buckhall is an important entry/exit point for loggers and ASM miners active in the region. The Project's port site at Buckhall is operated for the Project's private use and serves as the entry point for Project equipment and workers to be transported to the Aurora site via the Barama and Aurora access roads. For these reasons, the Buckhall community is included in the DAI.

The baseline study of the two communities within the Project's DAI was updated in 2012 and focused on relevant socioeconomic characteristics with particular emphasis on (1) socioeconomic data related to demographics, health, education, and employment; (2) land use and natural resource use for subsistence and livelihood activities; (3) social infrastructure such as schools, medical facilities, communications network/transport networks and markets; (4) public health; (5) local institutional capabilities; (6) land ownership; and (7) identification of concerns and issues which may affect the community and/or Project.

The 2012 study of these two communities relied upon three data collection methods:

- site visits, public consultation meetings, and participatory consultations;
- focused consultations with the Guyana Geology and Mines Commission (GGMC), Ministry of Amerindian Affairs (MOAA), and Amerindian Peoples Association (APA); and
- review and analysis of secondary data (e.g., previous Project reports and relevant legislation).

5.5.2 Detailed Baseline for Communities in the Project's DAI

This section presents the socioeconomic baseline for the communities that are part of the Project's DAI. The baseline is derived from consultations and interviews conducted with community members and site visits held in Aranka Mouth and Buckhall in 2012.

5.5.2.1 Aranka Mouth

Overview

Eighteen people were interviewed at Aranka Mouth on February 11th, 2012, for the purposes of this ESIA discussion.

Aranka Mouth (also known as Pigeon Island or Aranka Landing) is a small, transient unincorporated riverside community located on the opposite bank from the confluence of the Aranka Creek and the Cuyuni River in Administrative Region 7. The distance from Aranka Mouth to the Project site is approximately 14 km in a straight line and 16 km upstream (approximately 25 minutes by outboard engine boat) along the Cuyuni River.

The interviews indicated that Aranka Mouth consisted of 10 shops, 1 dwelling owned by a miner, a local office of the GGMC, and approximately 6 families (50–70 people). The shops provide food and beverages, entertainment, and accommodations for travelers on the Cuyuni

River and visitors from Aranka and Arangoy. The main economic activities other than shop ownership are small- and medium-scale mining and river transportation (including boat building). There is minimal infrastructure at Aranka Mouth. The only government presence was the GGMC office, which is only periodically manned.

Community History

Aranka Mouth was established in about 1996, at a time when there was an increase in medium- and large-scale gold mining activities in the Aranka Creek, Arangoy, and Ikawan gold mining areas. An increase in gold and diamond prices resulted in an influx of people to the area from Bartica, Brazil, Venezuela, and the Guyana coastland to engage in alluvial gold mining. This influx of miners resulted in entrepreneurs settling at Aranka Mouth to sell goods and services to the growing miner population.

The establishment of Aranka Mouth was attractive for people traveling along the Cuyuni River as they could stop at the community for accommodations, hot meals, and beverages, including alcoholic beverages. The community also provided employment opportunities for shop workers and commercial sex workers (CSWs). At the same time, there were negative impacts including an increased risk of infectious diseases, such as malaria, dengue fever, and typhoid fever, and there was also an increased potential for sexually transmitted infections (STIs).

Socio-Demographic Profile

Population

The Aranka Mouth population is dynamic in the same manner as the rest of the Project IAI. According to the 2012 interviews, there were between 50 and 70 people living in Aranka Mouth divided among approximately 6 families, with an average of between 4 and 9 people per household. Community members indicated the population has increased over the last 5 years due to an increase in gold and diamond prices, which has resulted in an increase in mining activities. According to “IFC Public Health Technical Assistance Program for Guyana Goldfields” (NewFields 2009), there were only between 20 and 50 residents at Aranka Mouth in 2009.

As noted above, most of the residents are shop owners who live only part time in Aranka Mouth, commuting back to Bartica, Georgetown, or elsewhere on a regular basis. Most households have family members who live permanently outside the community (primarily in Bartica and Brazil).

Demographics

The ethnic population of Aranka Mouth is varied and includes Afro-Guyanese, Indo-Guyanese, and mixed-race people. The population is approximately 36% adult male, 57% adult female, and 7% children. According to the residents interviewed, there were no vulnerable groups in the community (elderly, families headed by children, or people with special needs or health conditions). Average life expectancy is unknown.

The tables below show the breakdown of population in Aranka Mouth by sex and age.

Table 5.5-1. Approximate Number of Adult Males, Adult Females, and Children Living in Aranka Mouth.

Number of males (approx.)	20–25
Number of females (approx.)	30–40
Number of children (approx.)	3–5

Note: Data are based on the interview responses

Table 5.5.2. Approximate Age Breakdown of Aranka Mouth Residents

0–20 years	7%
21–64 years	93%
> 64 years	0

Note: Data are based on the interview responses

Religion

Based on responses obtained during the interviews for this study, none of the Aranka Mouth residents practice any form of organized religion as part of their life in the community.

Local Economy and Labor

The main economic activities in the community are business ownership (small shops that sell groceries and household items and provide entertainment and temporary accommodations for river travelers and small- and medium-scale gold mining), self-employed boat captains for river transportation, chain saw operators, boat builders/carpenters, and masons.

The number of persons employed by the shop owners varies throughout the year. Each of the 10 shop owners on average employs one person part-time (average bi-weekly wages GY\$30,000). The actual number employed per year depends on seasonal changes to the water level of the Cuyuni River, which affects business and mining activities.

Approximately 25–30 residents work outside the community at small- and medium-scale gold mining operations at Aranka Creek, Arangoy, and Julian Ross. Those residents are away for extended periods of time. Other residents sometimes work as attendants on boats transporting fuel from Venezuela.

Most women at Aranka Mouth are self-employed or business owners; some are employed in shops as attendants, and some may also work as CSWs. The number of CSWs and their significance to the Aranka Mouth economy was not forthcoming.

Land Use

The total area of Aranka Mouth is unknown. Residents have titled ownership of their land parcels, however, which were reportedly granted after they applied to the Ministry of Housing and GGMC.

Physical Infrastructure

Overview

There is minimal infrastructure in Aranka Mouth. There are no schools, landline or cellular phone service, health services, places of worship, social services, or access roads. Travel is accomplished via river motor boats, which all families own. There are approximately four computers in Aranka Mouth. Communication is mainly through internet calls and satellite phones.

There is no police or military presence. The only evidence of government presence is the sporadically manned GGMC office.

Electricity

Aranka Mouth is not connected to the national electric grid. Each household has its own generator to provide electricity for lighting, refrigeration, music, and other purposes. The generator is used mainly during daylight and early evening hours. During the night, residents use charged battery lamps in order to save on fuel costs. Households obtain diesel (and/or gasoline) to power the generators for approximately GY\$60,000 (US\$300) per 45–50 gallon barrel. Most fuel originates in Venezuela and is delivered by boat down the Cuyuni River. It is less expensive to purchase fuel from Venezuela than to have it transported to Aranka Mouth from Bartica or Georgetown.

Drinking Water

The main sources of drinking water are collected rainwater and purchased bottled water. Normally, the drinking water supply is sufficient, but rainwater supplies can be scarce during prolonged dry seasons. Purification of collected rainwater is not a routine practice.

Wastes

Organic and inorganic wastes are mostly buried, but some of the waste is thrown in the Cuyuni River. Excavated pits are used to dispose of refuse, and cesspools are used for sewage.

Cooking Fuel

Compressed cooking gas is used by most households, and a few households use wood as fuel for cooking. Compressed gas cylinders are transported from Bartica and/or Georgetown, and wood for cooking is obtained from the nearby forest.

Communication

There is no landline or cellular phone service available in the community, but there is limited access to the Internet. Communication is made by radio sets, satellite phones, or calls placed

over the Internet. Residents who have access to these services charge other residents for usage (on average, GY\$200 per minute for phone calls).

Transportation

There are no access roads to Aranka Mouth. The only means of access to and from the community is by river. Most people travel by outboard motor boats (75 horsepower or higher) made out of wood or metal. The cost to use a transportation service to travel by outboard from Aranka Mouth to Bartica is about GY\$18,000 per person one way.

River transportation from Aranka Mouth is available daily throughout the year. All residents own boats and use the river to travel to Aurora, Aranka, Bartica, Parika, Georgetown, and Venezuela. They travel to nearby mining areas and to Bartica and Georgetown for business, to obtain health services, to purchase goods and services, and to visit family and friends. Some boat workers travel on occasion to Venezuela. The river is also used by Guyanese coastlanders, Brazilians, and Venezuelans to transport fuel, mining equipment, workers, and supplies to mining areas.

According to the residents interviewed, business received from river travelers who stop at the community for accommodations, food, drinks, and other supplies has contributed to new business development and generates significant revenue for the residents. At the same time, the community's location on the river bank, with no police post nearby, makes it an easy target for crime.

Social Infrastructure (Education, Health, and Social Assistance)

Education

Based on the interviews associated with the questionnaire in Aranka Mouth, the majority of the adults had completed secondary schooling. However, as noted elsewhere, much of the population are economic commuters from Georgetown, Bartica, Parika, and elsewhere who came to establish shops in Aranka Mouth to take advantage of the economic demands associated with the ASM boom.

There are no schools in Aranka Mouth. The closest school is in Bartica. Residents with school-aged children (3.75 years of age and up) typically leave their children with family members back at their primary residences where education is available.

Health

There are no health services available in Aranka Mouth. Residents typically go to the Project medical clinics, Bartica Regional Hospital, or the Georgetown Public Hospital Corporation for medical treatment. Emergency evacuation by aircraft to Georgetown medical facilities is possible from the airstrip at the Aurora Gold Project, as well as via speedboat to Bartica Regional Hospital.

The most common diseases and health concerns in Aranka Mouth are malaria, dengue fever, typhoid fever, minor injuries, and musculo-skeletal pains. While some households use mosquito nets, others take no preventive measures. Aranka Mouth's location on the Cuyuni River and the

existence of the commercial sex trade make STIs (including HIV/AIDS) a concern to the residents, although the extent to which these diseases affect the population is unknown.

No information was available on fertility rates or childbirth. Typical causes of death listed in the interviews were assaults (usually caused by outsiders, primarily self-employed miners) and mining and river accidents, all which occur with some frequency. According to records kept at the Aurora Medical Center, for the period January 2011 to March 2012, there were four river accidents and six assaults, with one assault resulting in death.

Social Assistance Programs

No local or government sponsored social programs are available in the community.

Food Resources

Canned foods, some dry goods, fresh foods (including fruits and vegetables), wild game meat (mainly capybara and powis, a.k.a. Black Curassow, a bird species), and beverages including alcoholic beverages are available in the community.

Food resources include shops in the community and stores and outlets outside of Aranka Mouth. Wild game meat is primarily purchased from people up or down river. Residents do not actively hunt wild game. Hunting is done in an *ad hoc* manner by persons traveling to or engaged in gold mining activities along both banks of the Cuyuni River. While some residents may have small farming plots and raise small quantities of vegetables for their own consumption, this is not done on a large scale, and none of the produce is sold commercially. Beverages resold in Aranka are purchased mainly in Bartica.

According to the residents interviewed, food prices have increased over the past five years by approximately 40% to 50%. Prices for goods and services in the community have increased due to inflation and increased fuel prices.

Living Conditions

Housing

Most structures in the community serve a dual purpose; there is a shop in front and living quarters in the rear for the shop owner's family. The living quarters have two to three rooms, including a kitchen and a bathroom. The one-story wooden structures are raised off the ground to avoid flooding during seasons of heavy rainfall and to minimize the potential of being infected with malaria, dengue, and/or typhoid fever.

Shops and Services

There are several shops in the community, all owned by residents, selling food and drinks and dry goods, and some provide accommodations to river travelers who stop for the night at Aranka Mouth.

Entertainment/Recreation/Leisure Activities

Limited entertainment is available in the community. All of the shops have satellite television stations and also show videos. Most of the residents have DVD players, and four residents own computers.

Crime

Interviewees indicated that periodic assaults and robberies do occur (about once every two months). Robberies appear to be on the increase. These crimes are typically committed by outsiders traveling on the river (coastlanders and people from Bartica and the Essequibo Coast) and occur because there is no police post at Aranka Mouth or anywhere in the area. The residents have little means to protect themselves. The closest police station is in Bartica. A new police station is reportedly under construction in the Aranka mining area and will also serve Aranka Mouth; hence, there is some potential for crime rates to decrease when the new police station is staffed.

Public Sector: Local Organization

Government

There is no formal government in Aranka Mouth. GGMC has established an office in the community where mining officers periodically live and work. The officers are assigned to the office on a monthly rotational basis.

Governmental officials visit periodically (police officers and GGMC senior officers visit monthly, and political party representatives visit quarterly and at election time).

Community Expectations

Overview

The community members interviewed believe that there are numerous skilled workers in Aranka Mouth, including those experienced at navigating the Cuyuni River as boat captains, experienced boat builders, and chainsaw operators.

There are a number of issues that members of the community believe are important. These issues include the lack of permanent medical facilities and a security post, a growing population, refuse and sewage disposal, alcohol consumption, STIs, and the absence of facilities for youth development and life skills training.

Residents would like to see social programs established in the community, such as STI/HIV/AIDS counseling and education, as well as wellness and health education programs which focus on preventative measures. They would also like to see the government invest in programs to improve safety and security in the community.

Environment

The residents interviewed expressed concern about disposal of garbage in the Cuyuni River. They would like to see some improved means of waste disposal. In addition, the illegal fuel trade from Venezuela along the Cuyuni River sometimes involves barrels of fuel being floated in the river. When spillage of these fuel barrels occurs, it contaminates the water. Another environmental concern is deforestation resulting from housing construction and small-scale

mining activities. Residents interviewed believe these environmental problems can be solved by educating all residents on the impact this has on the community and the potential dangers it poses.

Expectations Regarding the Project

All interviewees were aware of the Project. Residents were formally informed during the public consultation held by GGI and ENVIRON on January 16, 2012. Residents believe the Project will have significant social impacts and will be a positive development in the area, due to the potential employment opportunities and community development. Some interviewees were concerned about the planned use of cyanide at the Project but understand it will be managed in accordance with international guidelines.

5.5.2.2 Buckhall

Overview

Twenty-two people were interviewed at Buckhall on March 30th, 2012, for the purposes of this study.

Buckhall (also known as Akarakura or Buckhall Port) is a small transient and unincorporated riverside community of 150–200 inhabitants located on the western bank of the Essequibo River in Administrative Region 3. Buckhall is an important entry/exit point for loggers and ASM miners active in the region, and it now serves as the entry point for Project goods and cargo to be transported to the Aurora Site via the primary road in the area, which is referred to as “M1” and the “new Aurora access road” further west. The distance from Buckhall to the Project site is approximately 130 km west in a straight line; by river, it requires a journey of 220 km upstream along the Essequibo (approximately 50 km) and then Cuyuni (approximately 170 km) Rivers. The most common means of travel from Buckhall to Aurora is 4 to 6 hours by road from Buckhall to Tapir Crossing and then 1 hour by river or the newly constructed Project access road from Tapir. The main economic activities in the community are logging, small business ownership (i.e., small shops that sell groceries and household items and also provide food and beverage services and temporary accommodations for river travelers), river/ground transportation, and farming. There is minimal infrastructure at Buckhall, and there is no permanent government presence. Barama is a commercial forestry company and has established several facilities in the community to support its operations.

Community History

Buckhall was established around 1925 as a small sporadically occupied farming and logging community. The establishment of large logging and timber operations and mooring and log loading facilities along the west bank of the Essequibo River, particularly at Buckhall, in the late 1980s to early 1990s brought significant development and changes to the community. During this period, people migrated to the area from the Coastland, Parika, Pomeroon River, Linden, and the Essequibo Coastal areas.

Barama obtained a large forestry concession and began operations in Buckhall in 2002. The company operates a sawmill, an operations department, a log pond, and living quarters for its employees in Buckhall. Barama has also developed a network of roads that service its forest

concessions. GGI and others use the M1 to gain road access to mining and forestry areas further west.

The construction of roads by Barama and other logging and timber companies improved road travel to the interior and accessibility for river transport. These roads also promoted small business development and mobility in the community. The residents of Buckhall view these changes and events positively. In the past it took three days to paddle from the west bank of the Essequibo River to Parika, whereas today most residents own outboard engines and boats, and can make this trip in 25 minutes.

Socio-Demographic Profile

Population

According to the 2012 socioeconomic baseline interviews, there were between 175 and 200 people living in Buckhall. There are approximately 15–20 families, with an average of between 5 and 10 people per household. In addition, there are two large extended families and a number of smaller 1-family households. Both males and females head households in this community. One member of a large extended family acts as an informal community leader, but there is no formal mayor or town council.

According to the ERM ESIA, the population of Buckhall in 2009 was estimated to be 65–70 persons. Average household size in the area at the time was 5 persons, and there were approximately 8–10 households in the area. Since 2009, the population of Buckhall has increased, mainly due to the presence of the logging companies (in particular Barama), which have created employment opportunities. Most of the new community members live in small households on small farming plots.

Buckhall is a transient community with some portion of the population migrating in and out in search of better employment opportunities and/or for family reasons. New people are moving to the community from Parika, Linden, and the Essequibo coastal areas and islands. Youths from the community leave for the interior to work in the gold mining industry. Men engaged in gold mining and log truck driving leave to work in the interior for extended periods returning occasionally for visits with their families. Women also leave the community if and when they find better employment opportunities elsewhere.

Demographics

The ethnicity of Buckhall's population is varied and includes Afro-Guyanese, Indo-Guyanese, and mixed-race people. The population is around 30% adult male, 45% adult female, and 25% children. According to the residents interviewed, there are no vulnerable groups in the community (e.g., the elderly, families headed by children, or people with special needs or health conditions). Average life expectancy is unknown.

The tables below show the breakdown of population in Buckhall by age and sex.

Table 5.5-3. Approximate Number of Adult Males, Adult Females, and Children Living in Buckhall

Number of males (approx.)	50–60
Number of females (approx.)	80–90
Number of children (approx.)	45–50

Note: Data are based on the interview responses

Table 5.5-4. Approximate Age Breakdown of Buckhall Residents

0–20 years	20%–25%
21–64 years	75%–80%
> 64 years	0

Note: Data are based on the interview responses

Religion

There are no churches, mandirs (Hindu temples), or mosques in the community. Community members are mainly Christian (Pentecostal and Anglican). While there have not been any events or festivals with a religious purpose in Buckhall, residents interviewed expressed interest in having places of worship established in the community.

Local Economy and Labor

Buckhall is an important entry/exit point for loggers and ASM miners active in the region, and GGI's leased wharf area and logistics support compound in Buckhall now serves as the entry point for Project goods and cargo to be transported to the Project via Barama Road and the Project's access road.

The main economic activities in the community of Buckhall are logging, small business ownership (a few small shops sell groceries and household items and also provide food and beverages and residences with temporary accommodations for river travelers), and river/ground transportation and services. Approximately 25% of the residents are employed in the community as boat captains, truck drivers, chainsaw operators, heavy-duty machine operators, mechanics, and shop workers. Their wages average GY\$90,000 per month. Wages have increased in the past five years. As an example, wages for a shop worker, which were GY\$60,000 to \$70,000 per month five years ago, are now GY\$90,000 per month.

Approximately 15% of the residents work outside the community in the gold mining and logging industries and are away for extended periods of time (typically one month for logging and longer periods for mining). Fifty of the residents are self-employed and support themselves in the

community by farming, managing shops, and running chainsaw operations. It is unknown what the remaining 10% of the population do to support themselves.

Most women at Buckhall are self-employed, some are engaged in farming, and others are employed as cooks or shop attendants. There is also prostitution at Buckhall. There were two households involved in commercial sex activities identified during the interviews, in addition to a nearby brothel. However, the number of CSWs and their significance to the Buckhall economy are unknown.

Land Use

The total area of Buckhall is unknown. Most residents rent the land on which they are living from the government. Only three families own the land on which they live, and these include the two large extended families.

Physical Infrastructure

Overview

There is minimal infrastructure in Buckhall. There are no schools, landline telephones, health services, places of worship, or social services. There are numerous access roads that connect Buckhall to the interior towards the west. These access roads are mainly used (and maintained) by Barama for logging. Travel is accomplished via riverboats or trucks, which most families own. Cell phone service is available in Buckhall and is the main form of communication. Internet access is limited to companies in the area and is not available to the local population.

Electricity

Buckhall is not connected to the national electric grid. However, households in the northern part of the community receive free electricity from Barama. Other households (further from the Barama facilities) have generators to produce electricity. Households obtain diesel (and/or gasoline) to power the generators for approximately GY\$35,000 to GY\$45,000 (US\$300) per 45-50 gallon barrel, which comes mostly from Parika across the Essequibo River.

Drinking Water

The main sources of drinking water are collected rainwater and purchased bottled water. On average, sufficient amounts of bottled water is available year round. Rainwater supplies can be scarce during the dry season. Collected rainwater is not routinely purified.

Wastes

Organic and inorganic waste are either buried or burned. Excavated pits are used to dispose of refuse, and cesspools and outhouses are used for human wastes.

Cooking Fuel

Compressed cooking gas is used by most households. A few households use wood as fuel for cooking. Compressed gas cylinders are transported from Parika, and wood for cooking is

readily available from logging activities nearby. Some residents with limited income gather wood from the forest.

Communication

There is no landline telephone service in the community. Cell phones are used for communication within and outside the community. Internet access is available at commercial companies in the area, but is not available to the Buckhall residents.

Transportation

Transportation to and from Buckhall is by river (via outboard motor boats) and the access roads (via trucks), and most households own their own motor boat and/or truck. The cost to use a transportation service to travel by motor boat from Buckhall to Parika is GY\$1,500 to GY\$2,000 per person one way and from Buckhall to the interior by truck is GY\$20,000 per person one way.

Access Roads

There are many networks of access roads from Buckhall to areas west of the Essequibo River. These roads are of good quality, having been constructed from laterite material by the large logging companies (mainly Barama) and are maintained by Barama who is now the primary user. These roads lead west to the Cuyuni River and gold mining areas and logging concessions, north to Region 1 and the Barama River, and south to the Caria Caria community.

The road networks are used daily by Barama and other logging companies, ASM miners, exploration companies, other private companies, and individuals traveling into the interior. They are used to transport goods, equipment, machinery, and personnel to work at gold mining sites and logging areas. Many types of equipment and vehicles use the road networks, such as all-terrain vehicles (ATVs), pick-up trucks, large 18-wheel trucks, and other types of vehicles. The roads are generally available throughout the year but may be closed by Barama at various checkpoints during periods of heavy rainfall.

According to the residents interviewed, access to the road networks has contributed to increased business opportunities for the community.

River Transportation

River transportation from Buckhall is available daily throughout the year and is provided mainly by community members who have outboard motor boats. The river is used to transport residents, individuals from outside the community, and miners' and loggers' goods, equipment, and machinery, and personnel.

Residents of Buckhall travel by river to and around the islands of the Essequibo River, such as Troolie Island for farming and Wakenaam to visit relatives. Children travel by river to Troolie Island and Caria Caria to attend school. Buckhall residents also travel by river to Parika to buy goods, equipment, and spare parts and to Bartica and Itaballi to transport goods and equipment. They may also travel periodically to Georgetown and other areas to obtain goods and services, purchase spare parts, visit relatives, or for social occasions such as sporting events.

Persons from outside the community travel by river to Buckhall to visit community residents and/or to pass through on their way into the interior. These persons include individuals, ASM miners, logging company employees, residents of coastland areas, and exploration companies.

According to the residents interviewed, access to the river has contributed to increased business opportunities for the community. The residents did not speak of any problems resulting from increased river transportation activities or from transients.

Social Infrastructure (Education, Health and Social Assistance)

Education

Approximately 70% of the population of Buckhall completed primary school, 20% completed secondary school, and 2% completed vocational training. The educational status of the other 8% was unknown. All residents interviewed were literate.

There are no schools in Buckhall. Children living in Buckhall attend nursery and primary schools at Grand Troolie Island (a small island community east of Buckhall in the Essequibo River) and at Caria Caria (a small community upstream on the west bank of the river from Buckhall) and they travel to school by motor boats. While education is valued in the community, children sometimes miss school due to transportation difficulties or if the weather is too severe for safe travel on the river.

Health

There are no health services available in Buckhall. Residents receive first aid and basic health services from Barama and at Parika from government facilities. Medical emergencies are evacuated to Georgetown or West Demerara Regional Hospital via engine boat to Parika.

There were no specific diseases or health issues identified by residents during the interviews. However, residents expressed concern about dust from passing vehicles and stagnant pools of water around the community due to logging activities. Residents did not report problems with malaria or dengue, but they did note that there are a large number of mosquitoes in the community. Data on these diseases were unavailable.

Buckhall's location on the Essequibo River, which makes it easily accessible, and the existence of CSWs make STIs (including HIV/AIDS) a risk, although the extent is unknown.

No information was available on fertility rates or childbirth. Persons interviewed could not identify health problems, behavior trends, or directly related causes of death in the community but stated that on occasion fatal accidents involving community members have occurred on the Barama Road.

Social Assistance Programs

No local or government sponsored social programs are available in Buckhall.

Food Resources

Fresh fruits and vegetables, ground provisions, canned food, fresh meat, fish, and wild game (e.g., powis and deer) are available in the community. Beverages are purchased at Parika and Georgetown.

Food resources include food grown on residents' own farming plots (fresh greens and root vegetables), food purchased from shops in the community, and food purchased from stores and outlets outside of Buckhall. Residents with farming plots sell some of their crops to other residents.

According to the residents interviewed, food prices have increased over the past five years, by approximately 20 to 30%. Prices for goods and services in the community are mainly dependent on fuel price stability.

Living Conditions

Housing

Houses in the community are built mainly from wood. Some residents have large two-story wooden dwellings with three to four rooms, while others have smaller dwellings. Some households have bathrooms and kitchens. Some residents own televisions, computers, and other electric appliances. Households that are close to the Essequibo River are at risk for flooding during periodic high tides.

Shops and Services

There are four resident-owned shops in the community. These shops sell food, drinks, and dry goods. Residents must shop outside Buckhall for home appliances and electronics.

Entertainment/Recreation/Leisure Activities

There are no entertainments or other recreational services available in the community.

Crime

Interviewees indicated that periodic assaults and robberies do occur. There is no police outpost at Buckhall. The closest police station is in Wakenaam, which is approximately 15 minutes away by boat.

Public Sector: Local Organization

Government

There is no formal government in Buckhall. There is an informal community leader who is a member of one of the large extended families. Government officials visit the community during election periods to hold discussions with Buckhall residents.

Community Expectations

Overview

The community members believe that the most significant strength of Buckhall is the infrastructure that was built by Barama, namely the road networks. There are a number of

issues that the community members believe are important, including the need for a school, health facilities, places of worship, a community center, recreation facilities including sports playing fields, and other programs and initiatives that involve community participation. Additional concerns included the transient nature of the community and the stagnant pools of water, which they believe could lead to an increase in vector-borne diseases among community members and Project workers.

Environment

The environmental concerns identified by community members during the interviews were dust from vehicles and equipment and stagnant water pools. According to the residents, these environmental concerns were caused by vehicles passing through the community transporting goods, logging, and excavation works. Residents mentioned that there has not been any recent deforestation in the area.

Expectations Regarding the Project

All community members interviewed became aware of the Project at the commencement of the development and construction of GGI's Buckhall camp which began in 2008. More recently, the residents received detailed information on the Project during the public consultation held on January 18, 2012, at Nursey's Landing.

Buckhall residents see the Project as a positive development for their community, similar to developments from other large agencies and companies such as Barama. Community members indicated that the Project is an important development and there may be positive social impacts to the community as the Project develops, including increased employment and new business opportunities from an increase in river traffic, access to electricity, and improved community infrastructure.

5.5.3 Communities in the Project's IAI

A desktop review was conducted on the available data for the three communities and one encampment included in the Project's IAI and relied primarily on the ERM ESIA. While these communities are not in the immediate vicinity of the Project site or its associated facilities, they are included in the IAI since some potential interaction with the Project may occur. In view of their distance from the Project facilities, it is unlikely that they will experience any negative impacts from the Project, although positive impacts such as jobs and/or opportunities to provide services to the Project are possible.¹¹

This section presents a brief overview of the communities which are part of the Project's IAI. Information provided below includes some data derived from the ERM ESIA, which may be referred to for additional detail.

¹¹ Titled Amerindian land locations are a considerable distance from the Aurora Gold Project site; see **Section 13, Indigenous Peoples** and **Figure 13.2-1, Amerindian Land Map** in particular.

5.5.3.1 Aranka

Aranka, an informal ASM encampment, is located in Region 7, approximately 30 km downstream of the Aurora Mine site along the Aranka Creek, a tributary to the Cuyuni River. Aranka was established about 100 years ago. Infrastructure in Aranka is limited and access is mainly via the Cuyuni River. Aranka has a history of mining activity and was used as the site for an initial GGI exploration camp. In the initial stage of mining activities in the Aranka area, gold mining was centered on Sir Walter Raleigh Creek, which is a tributary of the Aranka Creek. Aranka had a significant number of independent and transient ASM miners and significant commercial activity. Over the years mining activities have shifted from Aranka to Arangoy further to the east, and as a result, the number of people residing in Aranka has decreased significantly. According to GGI, there are now only 50 to 100 people living at Aranka. The Project will have little or no direct impact on Aranka, but, as an encampment within the Project region, it is considered to be part of the Project's IAI.

5.5.3.2 Parika

Parika is located in Region 3, roughly 65 km downstream from Bartica on the east bank of the Essequibo River and at the terminus of the main national road from Georgetown. Parika is a busy port town and has seven villages located within its administrative borders. It is a source of goods (especially fuel) and services for the interior and is the main transit point for access to the northwestern region of Guyana. However, Project materials traffic (e.g., fuel, machinery, construction materials, other consumables) will be transported directly to Buckhall via barge from Georgetown or the Port of Kingston, bypassing (and thereby having no impact on) the Port of Parika.

With respect to workforce traffic, it is envisioned that most Project workers traveling to and from Buckhall will be transported by Project-owned buses or other company vehicles, using the Georgetown - Parika road and the Demerara River toll bridge. From Parika, they will cross the Essequibo River to Buckhall on motor boats owned or leased by GGI. In 2011, it is understood that on average, 7,500 vehicles per day crossed the Demerara bridge. Additional traffic studies conducted for the Government of Guyana in 2012 as part of the West Coast Demerara Road Improvement Project indicate that on average, 6,294 vehicles per day travelled from the Demerara bridge on towards Parika.¹² This may be understood as a maximum daily average, as not all of the vehicles traveling on the Parika Road will travel all of the way to Parika proper. GGI estimates that the Project will make no more than 20 trips per week from Georgetown to Parika. As this represents only 0.3% of the maximum average daily traffic, the impact of Project traffic is not considered to be significant to Parika. Some limited interaction with the community may occur with workers in transit, but as all surface travel arrangements and schedules are directly controlled by GGI, no significant impacts are considered to be likely. Parika is therefore included in the Project IAI.

¹² See DIWI/Marcel Gaskin & Associates, 2012; DRAFT "Updating of Feasibility study and Design – West Coast Demerara Road Improvement Project, Vreed-en-Hoop West to Parika East"; DIWI Germany GMBH, Essen, Germany / Marcel Gaskin & Associates Ltd., Georgetown, Guyana, 2012.

5.5.3.3 Bartica

Bartica is located in Region 7, along the Essequibo River at the confluence of the Cuyuni and Mazaruni Rivers. Bartica's strategic location makes it a regional commercial hub, serving as a gateway to the interior. Bartica is also the administrative headquarters of the Regional Democratic Council of Region 7 and houses the Region 7 hospital and other regional administrative offices. Although GGI has no formal presence in Bartica and the Project is unlikely to cause direct impacts to Bartica, it is included in the IAI due to its regional economic and political importance.

5.5.3.4 Kurutuku

Kurutuku, established in 1966, is a titled Amerindian community which is located in Region 7 in the Upper Cuyuni River approximately 53 km by river from the Project site. The closest neighboring settlement to Kurutuku is San Martin, Venezuela. Currently, the community is accessed directly only by water transportation. Kurutuku has minimal infrastructure; residents use pit latrines and have no access to potable water or electricity. While there is a school and health post, they remain closed because there are no teachers or healthcare workers in the community. The most recent figures made public by the MOAA (2005) indicate that Kurutuku has a population of 127 persons. Members of the Kurutuku community are involved in subsistence activities (farming, fishing, and hunting), in addition to forestry, artisanal gold mining, and dredging for gold mining operations. Due to its remote location, Kurutuku is unlikely to experience any impacts as a result of the Project. Although, Amerindian communities are known to use the Cuyuni River to access areas both upstream and downstream of their village, the downstream areas are accessible only during the high water periods. Kurutuku is included in the IAI given its importance as the titled Amerindian community which is closest to the Project.

5.5.4 Other Project Beneficiaries

In 1996, GGI began an outreach employment program with an Amerindian community, St. Cuthbert's Mission. The program has been very successful, and currently 84 of St. Cuthbert's residents are employed at GGI. In view of GGI's positive experience with St. Cuthbert's, the program was extended in 2008 to include Maruca; approximately 60 Maruca residents are employed at GGI (ERM, 2010).

Recently, GGI began exploring how it could expand the program to include more Amerindian communities, and in January 2012 began a collaborative effort with the Amerindian People's Association (APA) to offer employment opportunities to additional Amerindian communities.

The location of these other project beneficiaries is shown in the map provided as **Figure 5-1**, and additional details are presented in the following paragraphs.

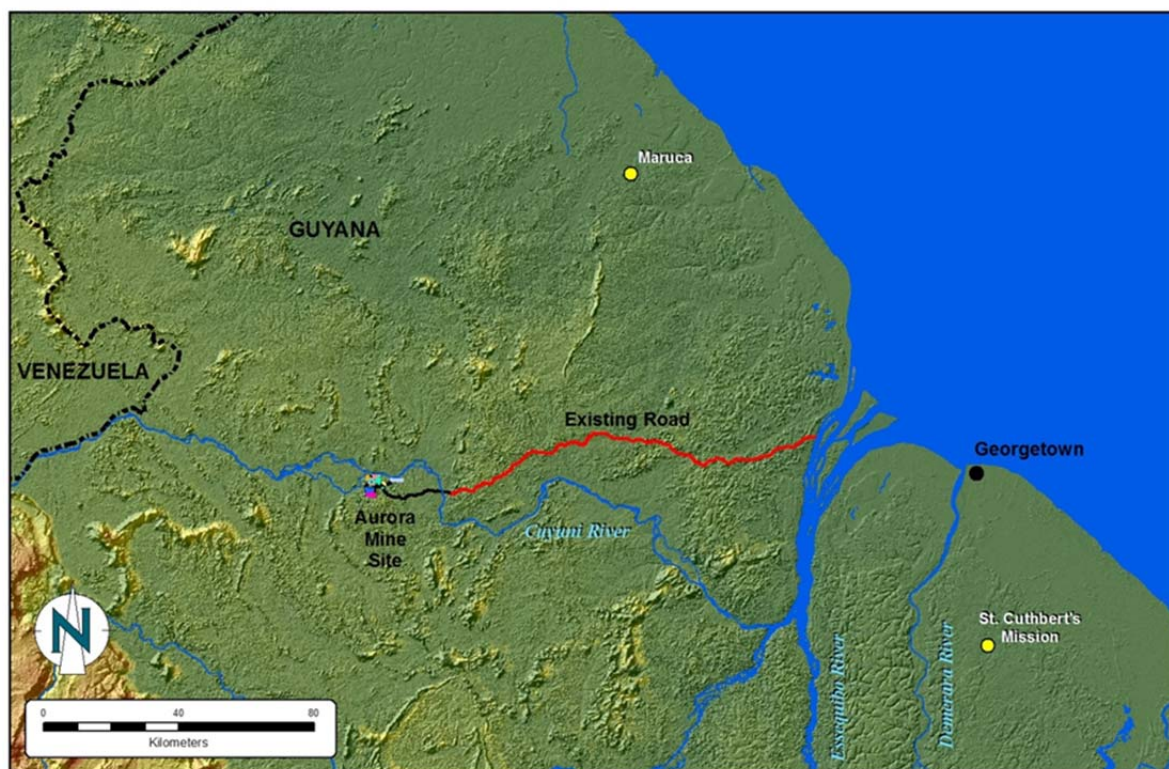


Figure 5.5-1. Location of Other Project Beneficiaries

5.5.4.1 St. Cuthbert's Mission

St. Cuthbert's Mission, established by the Arawak Amerindians around 1880, is a titled and demarcated Amerindian village. St. Cuthbert's is located in Region 7 and covers 67,678 hectares (ha) along the left bank of the Mahaica Creek. The total population is approximately 1,422, living in 284 households (as of 2010). St. Cuthbert's benefits from its close proximity to Georgetown and Linden (it is 56 km from Georgetown and 40 km from Linden). As a result, the village has better infrastructure than Amerindian communities in the interior and includes electricity for households in the central village, cell phone service, a community landline telephone, a large health clinic, and schools at all three levels (nursery, primary, and a large new secondary). More residents work outside the community than is typical for residents at Amerindian villages in the interior. The most important sources of income are lumbering and transportation services provided to loggers, followed by farming, handicraft production, and mining in the interior.

5.5.4.2 Maruca

Maruca, established by the Warau Amerindians, is a sub-region of Region 1 and is located along the western side of the Waini River. Maruca is comprised of a collection of villages, some of which are distinct islands in the rainy season when the area floods. A road network with bridges has been developed to link the communities. The villages are occupied mainly by Amerindians from the Arawak and Warau tribes. Maruca benefits from its close proximity to Charity on the Essequibo Coast. More residents work outside their community than is typical for residents at Amerindian villages in the interior. The most important sources of income are

lumbering, fishing and transportation services, followed by farming, handicraft production, and mining in the interior. Farming is done on a large scale and farmers transport their produce to Charity for sale. Like St. Cuthbert's, Maruca is more developed and has better infrastructure than Amerindian communities in the interior, and reportedly, almost every household has cell phone service. While there is electricity for households in the central village, the other smaller villages use generators and/or kerosene lamps.

Santa Rosa, the main village within Maruca, is a titled and demarcated Amerindian village. Maruca's total population is approximately 12,000. The highest concentration of the population is in the Santa Rosa/Kumaka area. Santa Rosa is the administrative center for Maruca, and its infrastructure includes a police station, district hospital and health center, post office, schools (nursery, primary, and secondary), a community landline telephone, a guest house, and shops, as well as an office of the Guyana Elections Commission.

5.5.5 Summary of Findings

All community members interviewed at both Aranka Mouth and Buckhall were aware of the Project and believe it will bring positive developments to their communities due to the potential employment opportunities at the Project, increased business opportunities, and community development.

During the study, the following observations and comments were made that are common to both communities:

- The communities are transient, unincorporated settlements along rivers.
- Their populations are increasing.
- They lack local government and leadership.
- There is minimal infrastructure and no security posts, schools, health clinics/medics, places of worship, or recreational facilities.
- There is low unemployment.
- Economic activities include shop ownership (providing food, beverages, groceries and accommodations for travelers), river transportation services, and ASM.
- There is a high cost for fuel, food, and other products bought locally.
- There is a poor water supply, and residents depend on bottled water and untreated rainwater.
- There is a commercial sex trade and the associated risk of STIs.
- There is no suitable means of refuse and sewage disposal.

In addition, the following observations and comments were made that are unique to each community:

- **Aranka Mouth**
 - Located 16 km downstream from the Aurora Mine Site;

- Established about 16 years ago;
 - People reside here on a short-term basis to conduct business and have permanent homes elsewhere in Guyana and Brazil;
 - School-age children live with family members in other communities where education is available;
 - All households have title to their land;
 - Prevalence of malaria, dengue fever, and typhoid fever;
 - Occasional assaults and robberies due to lack of security;
 - Only accessible by river; and
 - Environmental concerns include a current practice of disposing garbage in the Cuyuni River, the need for improved waste disposal, contamination of the river by Venezuelan fuel traders, and deforestation.
- **Buckhall**
 - Located adjacent to the Project's Buckhall logistics and port facility;
 - It was established about 87 years ago;
 - Key economic activity is logging;
 - School-age children live with their immediate families in the community and attend school in nearby communities;
 - Only three households have title to their land;
 - No diseases were reported;
 - A busy entry point to the interior and is accessible by river and the road network; and
 - Environmental concerns include dust generated from road traffic and equipment, and stagnant pools of water created by loggers.

With respect to the four communities/settlements located within the Project IAI, it is unlikely that they will experience any negative impacts from the Project. In fact, most have the potential to receive positive impacts, such as jobs and the opportunity to provide services to the Project. Two communities (Kurutuku and Bartica) and one encampment (Aranka) are geographically distant from the Project site and its associated facilities. Parika will most likely only be used as an occasional transit point for Project workers who are being transported to and from Buckhall via GGI-operated crew buses.

Through its voluntary outreach employment program with Amerindian communities, GGI has supported Amerindian workers and their families for more than 15 years by providing steady jobs, employee benefits, and skills training and thus, has elevated the workers' standard of living. GGI's current collaborative effort with APA to explore offering employment opportunities to residents of additional Amerindian communities will enable more Amerindians and their communities to benefit from this important Project initiative.

References

ERM, 2010; Final [sic] Environmental and Social Impact Assessment (ESIA) of the Aurora Mine Project in Guyana; Environmental Resources Management, Inc., Washington. DC, May 2010.

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World Bank, 2011; Migration and Remittances Factbook 2011, accessed at <http://issuu.com/world.bank.publications/docs/9780821382189?mode=embed&layout=http%3A%2F%2Fskin.issuu.com%2Fv%2Fflight%2Flayout.xml&showFlipBtn=true>; The World Bank, Washington, DC, 2013.

Section 6:
Risk and Impact Assessment

Contents

6 Risk and Impact Assessment	6-2
6.1 Introduction	6-2
6.2 Application of Mitigation Hierarchy in Development of Project Design	6-3
6.3 Risk and Impact Assessment Methodology	6-5
6.3.1 Risk and Impact Screening	6-5
6.3.2 Quantification of Risk and Impact Significance	6-5
6.3.3 Consideration of Residual Impacts	6-24
6.4 Cumulative Impacts	6-25
6.4.1 Definition and Assessment Approach	6-25
6.4.2 Cumulative Impacts on the Physical and Biological Environment	6-26
6.4.3 Cumulative Socioeconomic Impacts	6-32

List of Tables

Table 6.3-1:	Significant Environmental and Social Risks and Impacts, Associated Management/Mitigation Measures, and Residual Impact Considerations
Table 6.4-1:	Evaluation of Relative Significance of Cumulative Impacts

List of Figures

Figure 6.1-1:	Environmental and Social Risk and Impact Assessment – Screening and Refinement of Significant Risks and Impacts and Linkage to ESMS Continuous Improvement Process

6 Risk and Impact Assessment

6.1 Introduction

As noted in Section 1, this updated ESIA recognizes and builds on the results of the “Final [sic] Environmental and Social Impact Assessment (ESIA) of the Aurora Mine Project in Guyana” (ERM, 2010), taking into consideration the subsequent design changes represented in (TetraTech, 2013) and the results of the additional environmental and social baseline studies conducted on behalf of Guyana Goldfields, Inc. (GGI) from 2010 through the submittal date of this updated ESIA. In the identification of the environmental and social risks and impacts of the project, the assessment of impact significance, and the development of appropriate mitigation measures, due consideration has been given to:

- the impact assessment initially documented in Section 7 of (ERM, 2010)¹ and, for those impacts determined to be significant [i.e., assigned a “major” or “moderate” impact rating in (ERM, 2010)], refined in Section 20 and Table 20-1 of (TetraTech, 2013);
- identification of risks and impacts per International Finance Corporation (IFC) Performance Standard 1 (PS 1) (IFC, 2012a);
- the IFC’s Guidance Note on PS 1 (IFC, 2012b);
- the IFC’s “Environmental, Health, and Safety General Guidelines” (IFC, 2007a);
- the IFC’s “Environmental, Health, and Safety Guidelines for Mining” (IFC, 2007b);
- the IFC’s “Environmental, Health and Safety Guidelines for Toll Road” (IFC, 2007c);
- “Projects and People: A Handbook for Addressing Project-Induced In-Migration” (IFC, 2009);
- the International Cyanide Management Code (ICMC);
- other applicable standards and guidelines, as referenced;
- Section 4.3 (“Planning”) of ISO 14001 (International Organization for Standardization, 2004); and other applicable Good International Industry Practices (GIIPs).

Section 6.2 presents a review of the hierarchical mitigation process that has been applied in the development of the Aurora Gold Project (Project) design, and that is reflected in the identification of appropriate mitigation measures for the Project’s significant environmental and social risks and impacts. Section 6.3 reviews the overall assessment methodology, including discussion of (ERM, 2010) and its relationship to the presentation of impacts in Section 20 of (TetraTech, 2013) and this updated ESIA. Section 6.3 includes a refined, quantified, and

¹ See the “Environmental Impacts Summary and Ranking Table” in (ERM, 2010), pp. 7-52 to 7-71.

ranked summary of significant environmental and social impacts, along with any predicted residual impacts and anticipated management and mitigation measures (see **Table 6.3-1**). Section 6.3 also discusses the linkage between the refined assessment of significant impacts presented in **Table 6.3-1** and the management and mitigation of such impacts on a continuing basis over the entire mine life cycle, as an element of GGI's Environmental and Social Management System (ESMS). Section 6.4 summarizes the approach taken to identify and manage any cumulative impacts.

6.2 Application of Mitigation Hierarchy in Development of Project Design

In keeping with the requirements of IFC PS 1 (IFC, 2012), the Project has been designed using an iterative approach that has included three major feasibility studies:

- “Aurora Gold Project - Guyana, South America, NI 43-101, Technical Report on Updated Preliminary Assessment” (AMEC, 2009);
- “NI 43-101 Technical Report, Feasibility Study, Aurora Gold Project, Guyana” (SRK, 2012), and
- “NI 43-101 Technical Report: Updated Feasibility Study, Aurora Gold Project, Guyana, South America” (TetraTech, 2013).

In the development of the Project design, these studies have taken into consideration an overall mitigation hierarchy that preferentially avoids or prevents the incursion of environmental and social risks and associated impacts, and, where such prevention or avoidance is not possible, considers appropriate minimization and mitigation measures [e.g., progressive restoration of clearance areas; preferential use of previously impacted land areas; consolidation of the overall Project footprint; establishment of a workforce code of conduct and workforce/stakeholder grievance resolution processes; minimization of employee interactions with the residents of communities in the Project's area of influence (AOI)]. Where residual or cumulative impacts may be expected, compensatory or offset actions will be implemented as the last and least preferable option, where such options are financially and technically feasible. This same general mitigation hierarchy will be expressed in the management of the Project's environmental and social risks and impacts (including the detection and proactive management of new risks and impacts) over the long term, as discussed in Sections 3.2, 3.3, 4.1, and 4.2 of the Project *ESMS Plan* (see **Appendix 7A**) and the standard operating procedures (SOPs) cited therein (see **Appendix 7C**).

As discussed in Section 3, implementation of an iterative design process has involved the examination of major project alternatives and, as evidenced in the final design represented by (TetraTech, 2013) has achieved a 43% reduction in the Project's environmental footprint, thereby reducing required conversions of natural habitat. The Project has also achieved a significant reduction in its potential energy demands with associated collateral benefits in the reduction of greenhouse gas (GHG) and other emissions, as well as the minimization of the risks and impacts associated with the transportation and consumption of fuel. As noted in Section 5, the Project's social AOI has also been re-examined with respect to the Project design represented in (TetraTech, 2103) and updated information obtained in public outreach meetings

conducted in 2012, and the number of communities expected to remain within the Project AOI has been reduced to two.

6.3 Risk and Impact Assessment Methodology

6.3.1 Risk and Impact Screening

The Project's environmental and social risk and impact assessment process has progressed through three discrete stages of refinement, the results of which will be integrated into the continual improvement process embedded in the Project's ESMS; these stages are summarized graphically in Figure 6.3-1. Section 7 of (ERM, 2010) provided a detailed introduction to the various types of environmental and social risks and impacts² potentially associated with the Project, which were summarized in tabular format. Each identified risk or impact and its associated post-mitigation residual impact was rated as major, moderate or minor. This initial screening process was used as the basis for the identification of significant risks and impacts in Section 20 and Table 20-1 of (TetraTech, 2013). The risks and impacts listed therein include all "major" impacts from (ERM, 2010) plus a number of "moderate" impacts that were judged to be significant based on the most recent studies and available design information.

6.3.2 Quantification of Risk and Impact Significance

Table 6.3-1 of this updated ESIA is based on Table 20-1 of (TetraTech 2013), adjusted and expanded to include appropriate ESMS planning and procedural references in the discussion of management and mitigation measures, along with discussions of potential residual and cumulative effects, where applicable. Provisions are also made for the quantification and ranking of impacts as the basis for the prioritization of additional specific improvement actions that may be taken over time, above and beyond the mitigation actions already proposed.

The methodology for quantifying aspect significance in **Table 6.3-1** is designed to place the Project's significant negative aspects in a logical order, for implementation of appropriate management or mitigation measures as the project enters its major construction phase. This methodology generally considers an aspect to be "significant" if it is 1) legally regulated, or 2) known to be the subject of particular stakeholder interest, or 3) if one or more of the following conditions exist with regard to its associated environmental and social risks and impacts:

- the scale of any associated environmental or social impacts is large;
- a high probability exists that such risks will be expressed as actual impacts (i.e., they cannot be considered a rare event or transient condition);
- the impact has a long duration;

² IFC PS 1 defines "environmental and social risk" as "a combination of the probability of certain hazard occurrences and the severity of impacts resulting from such an occurrence". However, in general usage, "risks" are different from "impacts" in the sense that risks result from unlikely events or failures not generally associated with normal operating conditions or typical environmental or social conditions while most "impacts" are associated with standard conditions. For example, an event such as an accidental release of a hazardous material to the environment should be considered a "risk" rather than a reasonably predictable "impact." Thus, we are using "risks and impacts" in this section to broadly include both types of events or outcomes.

Figure 6.3-1: Environmental and Social Risks and Impacts Assessment – Screening and Refinement of Significant Risks and Impacts and Linkage to ESMS Continual Improvement Process

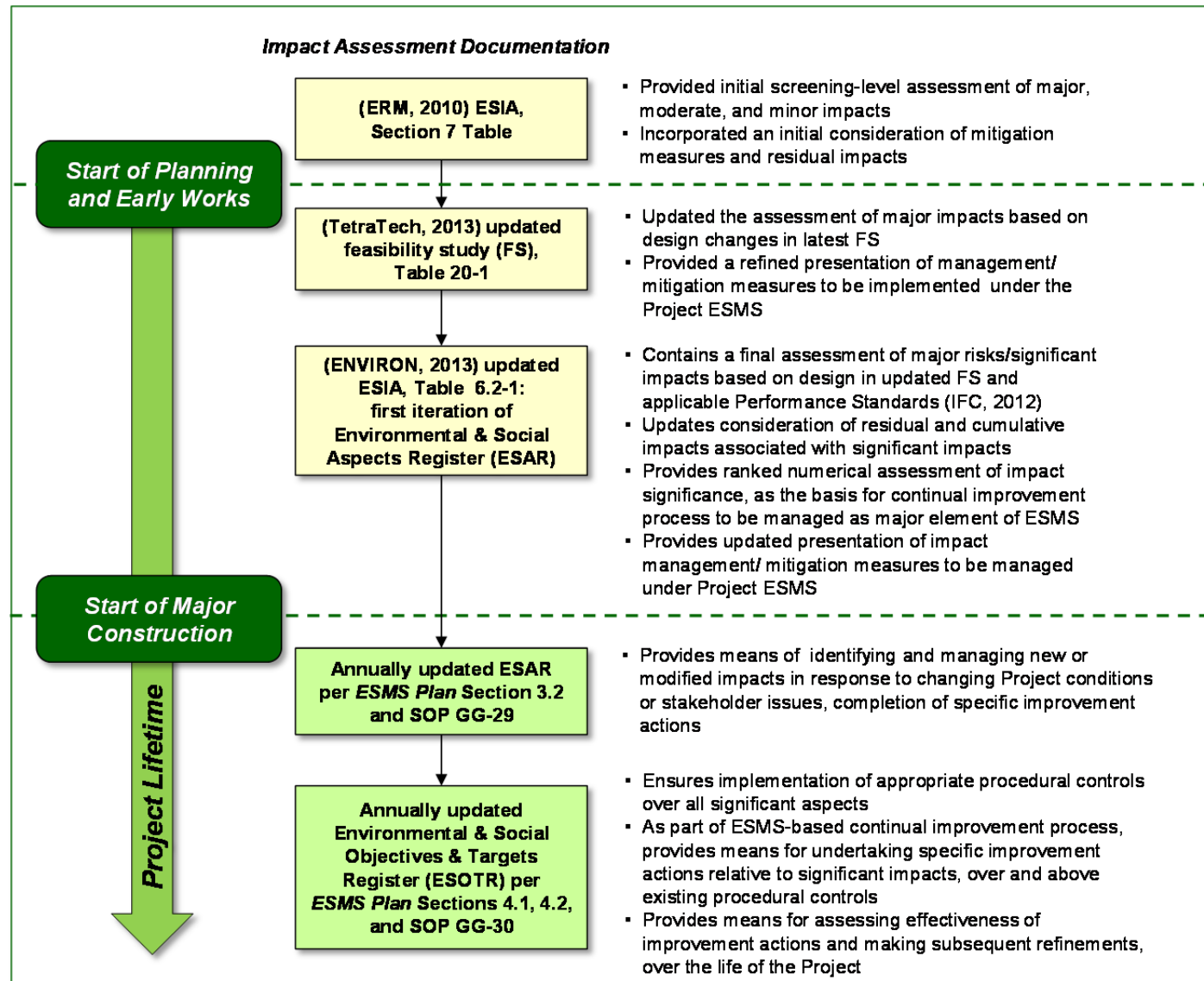


Table 6.3-1: Significant Environmental and Social Risks and Impacts, Associated Management/Mitigation Measures, and Residual Impact Considerations

Aspect Category	Aspect Description						Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)		
Aurora Access Road														
Impacts to terrestrial habitats and biota	Loss/alteration of 146.2 ha of terrestrial habitats cleared during construction of road from the existing Barama M3 to Aurora site	• Revegetation of 60.8 ha of road verges, reducing total road footprint to 85.4 ha. • Minimization of clearance actions/project footprint per GIIPs in the <i>Exploration Management Plan</i>, <i>Early Works Construction Management Plan</i>, and <i>Construction Management Plan</i> • Implementation of a routine biodiversity monitoring program within the Aurora concession per the <i>Biodiversity Management Plan</i> and <i>ESHS Monitoring Plan</i> • Implementation of progressive restoration and stabilization procedures for rights of way (ROWs) and artisanal/small-scale mining- (ASM-) disturbed areas, per the <i>Exploration Management Plan</i>, <i>Early Works Construction Management Plan</i>, <i>Construction Management Plan</i>, and <i>Mine Reclamation and Closure Plan</i> • Implementation of specific mitigation measures for the protection of sensitive species and habitats, as directed by the <i>Biodiversity Management Plan</i> • Implementation of GIIPs in the <i>Erosion Prevention and Control Plan</i> and <i>Water Management Plan</i> to manage stockpiles, and to detect and mitigate erosional issues in other disturbed areas • Restoration of ASM mined lands in Project Concession will partially offset reduction of forest areas by the Project.	• After revegetation, road clearance area will be 85.4 ha. • As the government of Guyana legally owns all roads created in Guyana and will most likely keep the road open after Project closure, the forest clearance impact related to the actual road ROW is likely permanent. The Project is in the process of reforesting verges cleared during construction but not essential for operation, which will reduce the road footprint. • Other residual impacts are considered not significant.	-	Yes	3	3	5	5	5	5	x 1.0	26	
Impacts to soils	Impacts to soils; 146.2 ha cleared during construction of road from the existing Barama M3 to Aurora site	• Revegetation of 60.8 ha of road verges, reducing total road footprint to 85.4 ha. • Implementation of the Project <i>Erosion Prevention and Control Plan</i>, including maintenance of topsoil/ organic matter stockpiles, and grading, scarifying, and re-vegetation of ROWs and other temporarily cleared areas adjacent to the roadway • Implementation of the <i>Spill Prevention, Control and Contingency Plan</i> and <i>Buckhall Spill Contingency Plan</i>, including spill kits on heavy equipment /passenger vehicles	• As the Government of Guyana will take ownership of the road, and presumably maintain it for use after Project closure, these impacts will be permanent. • No significant residual impacts.	-	Yes	3	2	5	5	5	5	x 1.0	25	

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Impacts to aquatic habitats	Loss/ degradation of aquatic habitats; 55 crossings of streams resulted in loss of approximately 2 km of impacts to existing streams.	• Maintenance of compliance with the ICMC and implementation of the <i>Cyanide Management Plan</i> • Purchase of cyanide exclusively in solid briquette form, transported in dedicated stainless steel ISO delivery/mixing tanks, delivered by an ICMC-certified transporter • Implementation of GIIPs in the <i>Erosion Prevention and Control Plan</i> and <i>Water Management Plan</i> to detect and mitigate areas of soil erosion, manage stormwater runoff, and control sedimentation on access road ROWs and other adjacent disturbed areas • Implementation of progressive restoration and erosional stabilization procedures for any excessively wide ROW areas, as well as any ASM-disturbed areas, per the <i>Mine Reclamation and Closure Plan</i> • Implementation of routine water quality monitoring program at stream crossings per the <i>ESHS Monitoring Plan</i> • Implementation of the <i>Spill Prevention, Control and Contingency Plan</i>, including the maintenance of spill kits on heavy equipment /trucks/passenger vehicles	• As the government of Guyana legally owns all roads created in Guyana and will most likely keep the road open after Project closure, the impacts to streams crossed by the road will likely be permanent. • Other residual impacts are considered not significant residual impacts.	-	Yes	2	3	5	5	5	5	x 1.0	25
Impacts to aquatic habitats	Loss of approximately 2 km of stream habitat due to road footprint (e.g., culverts at stream crossings; based on 44.3 m average clearing width and 55 crossings)	• Design culverts to properly handle natural surface water flows, per the Project <i>Erosion Prevention and Control Plan</i>; line with grass and/or riprap, where necessary to control flow rates/velocities and minimize erosion	• As the Government of Guyana will take ownership of the road, and presumably maintain it for use after Project closure, these impacts will be permanent. • No significant residual impacts.	-	Yes	2	2	4	5	5	5	x 1.0	23
Risk of impacts to soils and potentially aquatic habitats	Spills of fuel and other chemicals during transport between the Aurora site and Buckhall	• Maintenance of compliance with the ICMC, and implementation of the <i>Cyanide Management Plan</i> • Implementation of the Project <i>Erosion Prevention and Control Plan</i>, including maintenance of stockpiles, and -re-vegetation of ROWs and other cleared areas adjacent to the road • Implementation of the <i>Spill Prevention, Control and Contingency Plan</i> and <i>Buckhall Spill Contingency Plan</i>; placement of spill kits on all heavy equipment and passenger vehicles, and installation of emergency response stations at select locations along the access road • Inclusion of appropriate contractual requirements for spill prevention and control and maintenance of spill kits for all delivery contracts • Use of only ICMC-certified transporters for all cyanide deliveries • Establishment of contractual requirements for the trucking companies transporting other hazardous chemicals to have spill contingency plans and spill kits • Establish emergency response stations at selected locations on access road	• No significant residual impacts.	-	Yes	2	5	2	2	4	5	x 0.6	12

Aspect Category	Aspect Description						Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)		
Mine and mill/ process plant area														
Wastewater discharges and other releases to water	Sediment loading of surface water	- Installation of diversion structures to route un-impacted surface water around mining operations, and to route impacted surface water to the Mine Water Pond (MWP), Fresh Water Pond (FWP), and Tailings Management Area (TMA) - Construction of additional sedimentation ponds, as required, and implementation of other GIIPs in the <i>Erosion Prevention and Control Plan</i> and <i>Water Management Plan</i> (to be developed prior to the operational phase of the project) to manage waste rock, saprolite, and topsoil stockpile sediment runoff, and to detect and mitigate erosion in other disturbed areas - Implementation of progressive restoration and erosional stabilization procedures for areas historically disturbed by ASM, per the <i>Erosion Prevention and Control Plan</i>	No significant residual impacts given that no sediment should be discharged to the environment under normal operating conditions.	-	Yes	4	4	5	5	4	5	X 1.0	27	

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Impacts to terrestrial habitats and biota	Loss of terrestrial habitat and flora; 562 ha of existing tropical forest will be cleared	- Minimization of clearance actions/project footprint per the <i>Erosion Prevention and Control Plan</i>, <i>Exploration Management Plan</i>, <i>Construction Management Plan – Early Works</i>, and <i>Construction Management Plan</i> [to be developed by GGI's engineer/procure/construct (EPC) contractor] - Implementation of a routine biodiversity monitoring program within the Aurora concession per the <i>Biodiversity Management Plan</i> and <i>ESHS Monitoring Plan</i> - Implementation of specific mitigation measures for the protection of any identified sensitive species and habitats, per the <i>Biodiversity Management Plan</i> (to be developed prior to the operational phase of the Project) - Implementation of GIIPs in the <i>Erosion Prevention and Control Plan</i> and <i>Water Management Plan</i> to manage sediment generation from waste rock/topsoil stockpiles; and to detect and mitigate erosional conditions in other disturbed areas - Implementation of appropriate progressive restoration and erosional stabilization procedures for mined-out areas of the open pits, as well as ASM-disturbed areas, per the <i>Erosion Prevention and Control Plan</i> and <i>Mine Reclamation and Closure Plan</i>	No significant long-term residual impacts to terrestrial habitat and biota after restoration of affected areas. Restoration of areas affected by ASM in GGI concessions will contribute toward to goal of no net loss of natural habitats in the long term.	-	Yes	4	4	5	5	3	5	x 1.0	26

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Impacts to aquatic habitats	Loss of aquatic habitat; 12.4 km of streams will be lost, with an additional affectation of 9 crossings by the internal road network	• Installation of diversion structures to route un-impacted surface water around mining operations, and to route all impacted water to the MWP, FWP, and TMA and downstream sedimentation ponds as required • Implementation of GIIPs in the <i>Erosion Prevention and Control Plan</i> and <i>Water Management Plan</i> to manage topsoil/overburden stockpiles; and to detect and mitigate erosional conditions in other disturbed areas • Implementation of appropriate progressive restoration and erosional stabilization procedures for mined-out areas of the open pits, as well as areas disturbed by ASM, per the <i>Erosion Prevention and Control Plan</i> and <i>Mine Reclamation and Closure Plan</i> • Maintenance of compliance with the ICMC, and implementation of the <i>Cyanide Management Plan</i> • Implementation of a routine water quality monitoring program in the Cuyuni River and its tributaries as described in the <i>Water Management Plan</i> and <i>ESHS Monitoring Plan</i>	• No significant long-term residual impacts to aquatic habitat after restoration of affected areas. Restoration of areas affected by ASM in GGI concessions will contribute toward to goal of no net loss of natural habitats in the long term • In the event of any accidental releases or failures. Impacts will be of short duration and limited extent	-	Yes	3	4	5	5	3	5	x 1.0	25
Impacts to soils	Impacts to soils; 562 ha of existing tropical forest will be cleared	• Implementation of the Project <i>Erosion Prevention and Control Plan</i>; management of drainage and stormwater runoff on haul roads; maintenance of topsoil/organic matter stockpiles; and grading, scarifying, and re-vegetation of road rights-of-way (ROWs), exploratory roads, and other temporarily cleared areas • Implementation of appropriate progressive restoration and erosional stabilization procedures for disturbed areas per the Project <i>Erosion Prevention and Control Plan</i> and <i>Mine Reclamation and Closure Plan</i> • Maintenance of compliance with ICMC requirements with respect to the mixing, storage, and use of cyanide • Implementation of the <i>Spill Prevention, Control, and Contingency Plan</i>, <i>Hazardous Materials Management Plan</i>, and <i>Cyanide Management Plan</i> (to be prepared prior to any transportation of cyanide to the Aurora site)	• No significant residual impacts.	-	Yes	2	3	5	5	3	5	X 1.0	23

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Wastewater discharges and other releases to water	Modification of hydrologic flow patterns within streams/creeks from FWP, MWP, TMA and surface/ underground mining operations	• Installation of diversionary structures/diversion of un-impacted surface water around mining and processing operations to maintain biological base flows in Cuyuni River tributaries • Control of discharges from the FWP, MWP, and TMA into tributaries of the Cuyuni in accordance with the <i>Water Management Plan</i> and <i>Tailings Area Management Plan</i> (to be developed prior to the operational phase of the Project) in compliance with effluent discharge guidelines and/water quality standards defined by Guyana EPA, (IFC, 2007), and the ICMC	• No significant residual impacts.	-	Yes	2	2	3	5	2	5	x 1.0	19
Wastewater discharges and other releases to water	Potential runoff of impacted stormwater into surface water	• Diversion of un-impacted surface water around mining and processing operations • Installation of skimmers/oily water separators on mine wastewater discharges, with discharge reporting to the MWP for settling /dilution and testing prior to any controlled discharge • Collection (and as necessary treatment) of leachate from the onsite solid waste disposal facility prior to routing to the MWP • Collection of runoff from mining and process plant processing areas, stockpiles, and roadways, and retention in the MWP for settling and dilution prior to any potential controlled discharge • Regular monitoring of MWP water quality in accordance with the <i>Water Management Plan</i> and <i>ESMS Monitoring Plan</i> to ensure that controlled discharges meet quality standards defined by the Guyana EPA and (IFC, 2007) • Implementation of the Project <i>Erosion Prevention and Control Plan</i>; management of drainage and stormwater runoff on haul roads to minimize sedimentation; maintenance of topsoil/organic matter stockpiles; and grading, scarifying, and re-vegetation of road ROWs, exploratory roads, and other temporarily cleared areas	• No significant residual impacts.	-	Yes	3	2	2	3	5	5	x 0.4	8

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Wastewater discharges and other releases to water	Slope failure of waste rock and saprolite stockpiles, disrupting surface flows	- Operator training programs/ compliance with <i>Overburden Management Plan</i> (to be developed prior to the operational phase of the Project) - Periodic monitoring of the physical integrity of the waste rock and saprolite stockpiles, in accordance with the <i>Overburden Management Plan</i> and the <i>ESHS Monitoring Plan</i>, and regrading and/or strengthening of earthworks or other action as indicated by observed conditions	No significant residual impacts.	-	Yes	2	3	1	2	4	5	x 0.4	6.8
Wastewater discharges and other releases to water	Discharges of cyanide and other hazardous chemicals to surface water	- Maintenance of compliance with the ICMC, and implementation of the <i>Cyanide Management Plan</i> - Purchase of sodium cyanide reagent exclusively in solid briquette form, transported to the Project site in dedicated stainless steel ISO delivery/mixing tanks (see Figure 10.3-1) - Delivery of cyanide to the site using only an ICMC-certified transporter - Prohibition of any direct delivery of cyanide to the Aurora site using boats or barges on the Cuyuni and Essequibo Rivers - Implementation of the secondary containment, engineered spill prevention and control measures, and other GIIPs defined by the Project <i>Cyanide Management Plan</i>, the Aurora site <i>Spill Prevention, Control and Contingency Plan</i>, and the <i>Emergency Preparedness and Response Plan</i> - For non-cyanide reagents and fuel, implementation of the secondary containment and engineered spill prevention and control measures, remote fuelling control procedures, and other GIIPs defined by the <i>Hazardous Material Management Plan</i>, <i>Buckhall Spill Contingency Plan</i>, the Aurora site <i>Spill Prevention, Control and Contingency Plan</i>, and the <i>Emergency Preparedness and Response Plan</i>	Under normal operating conditions, cyanide and other hazardous conditions will not be discharged to surface waters in concentrations exceeding applicable standards. In the event of an accident or failures that result in discharges, the application of cleanup and remediation procedures should prevent any medium to long-term residual impacts.	-	Yes	3	3	1	1	5	5	x 0.2	3.6

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Wastewater discharges and other releases to water	Potential runoff or seepage of contaminated water from the TMA into surface water	• Maintenance of compliance with the ICMC, and implementation of the <i>Cyanide Management Plan</i> • Installation of supernatant pond barge and pumpback systems to return TMA reclaim water back to the process plant for industrial use • Installation of embankment seepage interception, collection, and return systems on TMA, as described in Section 5 of this Volume. • Construction of TMA in a low-permeability saprolite soil basin, supported by geological evaluation of the basin and local compaction, grouting, or other basin preparation actions during construction as necessary to ensure consistent low-permeability conditions • Inclusion of a series of redundant water management features (e.g., spillways, diversion ponds) in the TMA design) • Implementation of probabilistic water balance/water monitoring program for the TMA in the operational phase, in accordance with the <i>Tailings Management Plan</i>, <i>Water Management Plan</i>, and <i>Cyanide Management Plan</i> • Regular monitoring of TMA water quality in accordance with the <i>Tailings Facility Management Plan</i>, <i>Cyanide Management Plan</i> (to be prepared prior to any transportation of cyanide to the Aurora site), and <i>ESMS Monitoring Plan</i> to ensure that controlled discharges will be within Guyana EPA and (IFC, 2007) limits, as well as the free cyanide limits recommended by the ICMC for protection of aquatic life	• No significant residual impacts.	-	Yes	5	4	2	3	5	5	x 0.1	2.4

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Wastewater discharges and other releases to water	Breaches and overtopping of the FWP, MWP, and/or TMA	• Maintenance of compliance with the ICMC, and implementation of the <i>Cyanide Management Plan</i> • Provision of sufficient freeboard in the design of the MWP, FWP, and TMA based on the Probable Maximum Precipitation (PMP) event • Inclusion of sufficient contingency in the design of the MWP, FWP, and TMA embankments to withstand PMP events plus an appropriate safety factor • Independent dam safety/design reviews of all TMA embankments, as discussed in Section 5 of this Volume • Inclusion of a series of redundant water management features (e.g., spillways, dilution ponds, and sedimentation/polishing ponds) in the TMA design • Rigorous independent Construction Quality Assurance (CQA) oversight of MWP, FWP, and TMA embankment construction • Development and implementation of probabilistic water balance/monitoring program and other GIIPs for the MWP, FWP, and TMA, in accordance with the <i>Tailings Area Management Plan</i>, <i>Water Management Plan</i>, and <i>Cyanide Management Plan</i>	• No significant residual impacts.	-	Yes	5	5	1	2	5	5	x 0.1	2.3
Wastewater discharges and other releases to water	Potential failure of the TMA and MWP dams after completion of mining activities	• Stabilization, pumpdown, closure, and selective re-vegetation of tailings surfaces and embankments per the final <i>Detailed Mine Reclamation and Closure Plan</i> • Post-closure monitoring of the stability of the reclaimed MWP, FWP, and TMA areas and periodic monitoring of downgradient surface and groundwater conditions per the final <i>Detailed Mine Reclamation and Closure Plan</i> and <i>ESHS Monitoring Plan</i>	• No significant residual impacts.	-	Yes	4	5	1	2	5	5	x 0.1	2.2

Aspect Category	Aspect Description					Ranking (- aspects only) Impact significance							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Wastewater discharges and other releases to water	Diesel oil spill into the Cuyuni River	• Implementation of the secondary containment and engineered spill prevention and control measures, remote fuelling control procedures, oily water separators/treatment systems, and other GIIPs per the <i>Hazardous Material Management Plan</i> and <i>Spill Prevention, Control and Contingency Plan</i> • Implementation of the Project's preventive maintenance (PM) and field inspection programs for the operation of the fuel farm, emergency generator area, and fuelling station • Installation of skimmers/ oily water separators on mine wastewater discharges, reporting to the MWP for settling and dilution prior to any controlled discharge • Regular monitoring of MWP water quality in accordance with the <i>Water Management Plan</i> and <i>ESMS Monitoring Plan</i> to ensure that controlled discharges will be within the effluent discharge guidelines and/water quality standards defined by the Guyana EPA and (IFC, 2007)	• No significant residual impacts.	-	Yes	4	4	1	1	5	5	x 0.1	2

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Wastewater discharges and other releases to water	Cyanide spill into the Cuyuni River or its tributaries	• Maintenance of compliance with the ICMC, and implementation of the <i>Cyanide Management Plan</i> • Purchase of sodium cyanide reagent exclusively in solid briquette form, transported to the Project site in dedicated stainless steel ISO delivery/mixing tanks • Delivery of cyanide to the site using only an ICMC-certified transporter • Restriction of Tapir Crossing ferry to transportation of only one ISO delivery/mixing tank at a timeProhibition of any direct delivery of cyanide to the Aurora site via the Cuyuni River using boats or barges • Implementation of the secondary containment, engineered spill prevention and control measures, and other GIIPs defined by the Project <i>Cyanide Management Plan</i>, and <i>Emergency Preparedness and Response Plan</i> • Implementation of operational practices in the process plant that minimize the potential for process upsets, as noted in the Project <i>Cyanide Management Plan</i> (to be prepared prior to any transportation of cyanide to the Aurora site) • Design and operation of the tailings detoxification circuit to routinely achieve a nominal 0.5 mg/L weak acid dissociable cyanide (WAD_{CN}) in the tailings pipeline and as-deposited tailings • Implementation of the Project’s Preventive Maintenance (PM) and field inspection program for the operation of the process plant	• No significant residual impacts.	-	Yes	2	5	1	1	5	5	x 0.1	1.9

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Wastewater discharges and other releases to water	Infiltration of potential spills or discharges of cyanide and other chemicals into groundwater	• Maintenance of compliance with the ICMC, and implementation of the <i>Cyanide Management Plan</i> • Purchase of cyanide exclusively in solid briquette form, transported in dedicated stainless steel ISO delivery/mixing tanks • Implementation of the secondary containment, engineered spill prevention and control measures, and other GIIPs defined by the <i>Project Cyanide Management Plan</i> and <i>Emergency Preparedness and Response Plan</i> • Implementation of operational practices in the process plant that minimize the potential for process upsets, as noted in the <i>Project Cyanide Management Plan</i> (to be prepared prior to any transportation of cyanide to the Aurora site) • Design and operation of the tailings detoxification circuit to routinely achieve a nominal 0.5 mg/L weak acid dissociable cyanide (WAD_{CN}) in the tailings pipeline and as-deposited tailings • For other (non-cyanide) reagents and fuel, implementation of the secondary containment and engineered spill prevention and control measures, remote fuelling control procedures, oily water separators/treatment systems, and other GIIPs defined by the <i>Hazardous Material Management Plan</i>, <i>Buckhall Spill Contingency Plan</i>, the Aurora site <i>Spill Prevention, Control and Contingency Plan</i>, and the <i>Emergency Preparedness and Response Plan</i>	• No significant residual impacts.	-	Yes	2	5	1	1	5	5	x 0.1	1.9
Wastewater discharges and other releases to water	Potential infiltration of surface water from the Cuyuni River into open pit/ underground mine	• Construction of the Cuyuni River dike system, including relief wells; see Appendix 2A, DWG-C0105 and –C0115 • Routine monitoring of river height and potential erosion per the <i>Water Management Plan</i> and <i>Erosion Prevention and Control Plan</i>	• No significant residual impacts.	-	Yes	4	4	1	2	4	3	x 0.1	1.8
Wastewater discharges and other releases to water	Potential runoff or seepage of leachate from the Solid Waste Landfill	• Collection and periodic testing of leachate from landfill; if testing results indicate effluent quality issues with respect to Guyana EPA or (ICMC, 2007) guidelines, route to the MWP for dilution and storage or install local water treatment system	• No significant residual impacts.	-	Yes	1	2	1	1	5	5	x 0.1	1.5

Aspect Category	Aspect Description						Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)		
Buckhall logistics support facility														
Impacts to soils	Impacts to soils	• Implementation of the <i>Erosion Prevention and Control Plan</i>, including maintenance of stockpiles and re-vegetation of cleared areas in or near Buckhall compound • Implementation of remote fuelling control procedures and other GIIPs per the <i>Hazardous Material Management Plan</i> and <i>Buckhall Spill Contingency Plan</i> • Placement of spill kits in all heavy vehicles operating within the Buckhall compound	• No significant residual impacts.	-	Yes	2	2	5	5	3	3	x 1.0	20	
Wastewater discharges and other releases to water	Accidental discharges of fuels, oils and grease from equipment and/or from the failure of fuel containment facilities	• Use of spill response kits and implementation of the other GIIPs applicable to the fuel storage facility, per the <i>Hazardous Material Management Plan</i> and <i>Buckhall Spill Contingency Plan</i>	• No significant residual impacts.	-	Yes	5	5	1	1	5	5	x 0.1	2.2	
Wastewater discharges and other releases to water	Spills of fuel and other chemicals being loaded/unloaded at the port	• Maintenance of compliance with the ICMC, and implementation of the <i>Cyanide Management Plan</i> • Purchase of cyanide exclusively in briquette form, delivered in dedicated stainless steel ISO containers, using only ICMC-certified transporters • Implementation of the <i>Erosion Prevention and Control Plan</i>, including maintenance of stockpiles and re-vegetation of cleared areas in or near the Buckhall compound • Implementation of the remote fuelling control procedures and other GIIPs per the <i>Hazardous Material Management Plan</i> and <i>Buckhall Spill Contingency Plan</i> • Provision of spill kits for all heavy vehicles operating within the Buckhall compound • Use of portable floating booms and spill response kits around the Buckhall fuelling terminal and implementation of the secondary containment and other GIIPs at the fuel storage facility, per the <i>Hazardous Material Management Plan</i> and <i>Buckhall Spill Contingency Plan</i>	• No significant residual impacts.	-	Yes	3	4	1	1	5	5	x 0.1	1.9	

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Wastewater discharges and other releases to water	Potential runoff or seepage of leachate from the Buckhall Solid Waste Landfill	Collection and testing of leachate from landfill; if test result so indicate, installation of treatment system prior to discharge	• No significant residual impacts.	-	Yes	1	2	1	1	5	5	x 0.1	1.5
Other Macro Impacts													
Community issues/external stakeholder relations	Impact on socioeconomic conditions of the nation after completion of the operations phase	• Implement the Project <i>Community Relations Plan</i>, <i>Influx Management Plan</i>, and final <i>Detailed Mine Reclamation and Closure Plan</i>; key actions will include: – provision of appropriate retrenchment compensation for the mine workforce, as described in the and final <i>Detailed Mine Reclamation and Closure Plan</i> – diversification of skills/training, and building capacities of former workers and service providers to find economic opportunities with other industries in Guyana; and – targeting of workers' families and Amerindian communities for income generation projects • Implement selected public/community development projects	• No significant residual impacts.	-	Yes	3	3	5	5	3	2	x 1.0	21
Community issues/external stakeholder relations	National socioeconomic impacts due to Aurora mine closure	• Provide appropriate retrenchment compensation for the mine workforce, to be described in the final <i>Detailed Mine Reclamation and Closure Plan</i> • Provide diversified skills training to build capacities of former workers and service providers to find economic opportunities with other industries in Guyana • Target workers' families and Amerindian communities for income generation projects • Implement selected public/community development projects via the <i>Community Relations Management Plan</i>	• No significant residual impacts.	-	Yes	3	3	5	5	3	2	x 1.0	21
Community issues/external stakeholder relations	Potential issues with artisanal mining	• Continued consultation and engagement with illegal/artisanal miners in accordance with the <i>Influx Management Plan</i>, <i>Community Relations Management Plan</i>, and the public grievance procedures in the <i>ESMS Plan</i>	• No significant residual impacts.	-	Yes	3	4	3	2	3	5	x 0.7	14

Aspect Category	Aspect Description					Impact Significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Community issues/external stakeholder relations	Potential influx into leading to health, security and conflict related risks	• Hiring advertised and controlled through Georgetown office • Control of employee travel to and from the Aurora site using GGI vehicles • Prohibition or strict regulation of economic or social contacts by workforce or contractors with transients or local communities • Prohibition of public (transient) access to the mine, mill, mechanical shops, fuel storage areas, TMA/MWP/FWP areas, man-camp, solid waste landfill, water supply system, airstrip, explosives silos and magazine, and other sensitive locations; such prohibitions are to be communicated via mechanisms in the <i>Community Relations Management Plan</i> and <i>Influx Management Plan</i>, and the public grievance procedures in the <i>ESMS Plan</i> • Partner with Barama Company, Ltd. and the Government of Guyana to monitor and manage influx issues per the <i>Influx Management Plan</i> and <i>Community Relations Management Plan</i> • Consult with the Government on issues such as promotion of planned regional development • Promote and implement health awareness campaigns among workers and contractors, as well as local communities upstream and downstream of project site	• No significant residual impacts.	-	Yes	3	4	3	1	3	3	x 0.7	11.9

Aspect Category	Aspect Description					Impact significance Ranking (- aspects only)							Impact Score
	Known or Potential Risk or Impact	Management/Mitigation Measures	Residual Impacts Post-Mitigation	+ or – impacts?	Regulated or Open Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Community issues/external stakeholder relations	Potential influx into Buckhall due to wharf development	• Train GGI security personnel to monitor potential influx, and to handle influx without creating conflict or security issues, in accordance with the <i>Influx Management Plan</i> and <i>Community Relations Management Plan</i> • Partner with the Government and/or Barama to plan sustainable development/ growth of the Buckhall community, per <i>Influx Management Plan</i> requirements. • Consultation with the Government on promotion of planned regional development • Hiring advertised and controlled through Georgetown office • Control of employee travel to and from site using GGI vehicles • Prohibit public access to the Municipal Solid Waste Landfill • Promote and implement health awareness campaigns among workers and contractors, as well as local communities upstream and downstream of the project site.	• No significant residual impacts.	-	Yes	3	3	2	2	3	3	x 0.7	11.2
Community issues/external stakeholder relations	Potential influx to the mine site and related environmental and social risks	• Train GGI security personnel to monitor potential influx, and to handle influx without creating conflicts or worsening security issues, in accordance with the <i>Influx Management Plan</i> and , the public grievance procedures in the <i>ESMS Plan</i>, and applicable sections of the <i>Community Relations Management Plan</i> • Partner with the Government and/or Barama to plan sustainable development/ growth of the Buckhall community, per the <i>Influx Management Plan</i> and applicable sections of the <i>Community Relations Management Plan</i> • Consultation with the Government on promotion of planned regional developments • Prohibition of onsite hiring/hiring opportunities advertised and controlled through GGI's Georgetown office • Control of employee travel to and from site using GGI vehicles • Prohibit public access to the Solid Waste Landfills • Promote and implement health awareness campaigns among workers and contractors, as well as local communities upstream and downstream of the project site	• No significant residual impacts.	-	Yes	3	5	3	3	3	5	x 0.5	11

- the impact may result in regulatory or legal exposure;
- the risk or impact is technically difficult or expensive to manage or to mitigate;
- the risk or impact is known to be of substantial concern to local communities or other external stakeholders; or
- if expressed as an actual impact, the risk has the potential for negatively affecting public perception of GGI's ability to predict, identify, manage, and mitigate the Project's environmental and social risks and impacts.

Relative significance is determined on the basis of professional experience in the assessment of environmental and social risks and impacts, in conjunction with the institutional knowledge held by GGI as a result of its years of experience in Guyana and especially from the exploration phase of the Project. Six basic factors are considered in the quantification of significance:

- the relative **scale**, **severity**, **frequency**, **duration** of the impact;
- GGI's relative **ability to influence** impact scale, severity, frequency, or duration; and
- the potential for a negative public **image** or perception of the Project with respect to the management of environmental and social risks and impacts.

As noted in **Table 6.3-1**, each factor was ranked numerically from 1 to 5, with 5 representing a worst-case scenario for all factors except "ability to influence," for which a higher ranking indicates a generally greater ability to influence on GGI's part, the assumption being that those aspects clearly within GGI's ability to influence merit more immediate action. These rankings were added, and the sum then multiplied by a probability factor of 0.1 to 1.0, 1.0 representing the most certain condition (i.e., highly likely to occur) and 0.1 being the most uncertain or least likely to occur. The resulting composite impact score is recorded in ranked sequence for each major project component [i.e., the Aurora site, the Barama (M3)/Aurora extension road, and the Buckhall logistics support center]. This process is further elaborated and codified in Sections 3.2, 3.3, 4.1, and 4.2 of the Project *ESMS Plan* (see **Appendix 7A**) and GG-29, "Determination of Environmental and Social Aspects and Significant Impacts" (see **Appendix 7C**). The results documented in **Table 6.3-1** will be integrated into the first iteration of the Project's Environmental and Social Aspects Register (ESAR), as discussed in GG-29.

As the Project enters the major construction phase, the ranked risks and impacts in the initial version of the ESAR will be used as the basis for the development of periodically updated and prioritized environmental and social objectives and targets for performance improvement, as discussed in Sections 4.1 and 4.2 of the Project *ESMS Plan* (**Appendix 7A**) and GG-30, "Environmental and Social Objectives, Targets, and Performance Improvement Program."

In summary, the most significant risks and impacts identified and progressively refined in the ESIA process are presented in **Table 6.3-1** for each major Project area. These risks and

impacts will be systematically managed over the life of the mine through processes that not only ensure the establishment of appropriate procedural or planning controls as part of risk and impact mitigation, but also ensure the regular assessment of such risks and impacts (or new risks and impacts) with respect to potential improvements. Where improvement potential is identified, the process also ensures that appropriate improvement actions are actually implemented and assessed for effectiveness. These processes are embodied in (and will be implemented in the context of) a Project-specific ESMS designed to comply with PS 1 requirements. As such, these processes will be subject to specific change management controls to ensure that mitigation measures are appropriately updated in response to changing environmental considerations, facility modifications or expansions, process changes, or other changes that may occur over the life of the mine. See Section 7 of this updated ESIA for further discussion.

6.3.3 Consideration of Residual Impacts

It should also be noted that **Table 6.3-1** documents potential residual impacts, which were assessed by evaluating the likely effectiveness of the proposed management and mitigation measures for the purpose of identifying any significant impacts that may require additional measures such as restoration, compensation, or offsets, wherever such options are technically and financially feasible. Section 7 of (ERM, 2010) assessed nearly all impacts as having only minor residual impacts, except for the following (which were considered to have moderate residual impacts):

- loss of terrestrial habitat and flora;
- breaches or overtopping of the TMA and/or mine water management pond;
- potential failure of the TMA and water management pond dams after completion of mining activities;
- spills of fuel and other chemicals during transport between the Aurora site and the Buckhall logistics support facility;
- facilitation of commercial logging activity to the south of the Cuyuni River;
- impact on socioeconomic conditions of the nation of Guyana during operations phase; and
- impact on to socioeconomic conditions of the nation of Guyana due to closure.

In terms of logging south of the Cuyuni River, Barama Company Ltd. (Barama) holds concessions in this area, and GGI is obliged to allow Barama access to these resources. However, GGI will control and monitor access to Tapir Crossing and the Aurora (M3) road extension, and will report any observations of illegal logging to Barama as well as the Guyana Police Force (GPF) and Guyana Forestry Commission (GFC); see the *Influx Management Plan* in **Appendix 7B**, as well as Section 10 of this updated ESIA. The impact identified by (ERM,

2010) is therefore not considered to require any additional action on the part of GGI, and is not included in **Table 6.3-1**.

With respect to the other potential residual impact areas noted above, no significant (i.e., “major”) residual impacts were identified by (ERM, 2010) or this updated ESIA, and thus no additional compensations or offsets have been proposed per PS 1 guidance. However, the Project is committed to the goal of achieving “no net loss” of natural habitats wherever feasible, and GGI will seek to restore ecological processes and biodiversity to areas affected by ASM activities within its concessions via implementation of the *Erosion Prevention and Control Plan*, *Biodiversity Management Plan*, and *Mine Reclamation and Closure Plan*; see the summaries of plan content in Section 7.2.2 of this updated ESIA.

6.4 Cumulative Impacts

6.4.1 Definition and Assessment Approach

Paragraph 39 of the IFC’s Guidance Note to PS 1 (IFC, 2012b) defines cumulative impacts as those impacts that result from the incremental impact of the project when added to other existing, planned and reasonably predictable future projects and developments. PS 1 paragraph 8 notes that a project’s area of influence includes areas or resources used or directly impacted by incremental impacts from other existing, planned or reasonably defined developments at the time the Project’s risks and impacts identification process is conducted. PS 1 limits cumulative impacts to those impacts generally recognized as important on the basis of scientific concerns and/or concerns originating with affected communities.

Examples of typical cumulative impacts include: incremental contributions of gaseous emissions to an airshed; reduction of water flows in a watershed due to multiple withdrawals; increases in sediment loads to a watershed; interference with migratory routes or wildlife movement; or increased traffic congestion and accidents due to increases in vehicular traffic volumes on community roadways (IFC, 2012a).

As of the publication date of this updated ESIA, there are no other existing, planned or reasonably defined developments in or near the Project’s environmental and social AOI, with the exception of on-going ASM and commercial logging activities in the Barama forestry concession. There are also no existing or proposed regional development plans or projects for the lower Cuyuni basin. Therefore, the only potential cumulative impacts currently foreseeable in the Project’s area of direct influence are those which relate to the impacts of ASM, or potentially the expansion of the Project (which is not planned at this time). At the national level, cumulative impacts will depend in significant part upon the presence or absence of other major projects that may provide other sources of economic development during the life-cycle of the Project.

GGI is committed to a partnership role in Guyana’s economic development through socially and environmentally responsible mining practices in keeping with GGI’s “Sustainability Principles”³

³ www.guygold.com/main1.aspx?id=27

and the Project's Human Resources, Community Relations, and Environmental, Health and Safety Policies [see Appendix C of the Project *ESMS Plan* (**Appendix 7A**)]. GGI will therefore seek opportunities to engage and collaborate with the Government of Guyana and regional administrations on environmental and socioeconomic matters relating to cumulative impacts of future developments in the Project AOI, including assisting in the development of sustainable local policies and the prevention or minimization of impacts on the natural landscape and to the well-being of the workforce and local communities. GGI has incorporated the assessment of potential cumulative impacts into the overall environmental and social performance improvement process discussed in Section 6.3 of this updated ESIA, and further elaborated in Sections 3.2, 4.1, and 4.2 of the Project *ESMS Plan* (see **Appendix 7A**). General considerations contributing to the identification of cumulative impacts are discussed in Sections 6.4.2 and 6.4-3 below. **Table 6.4-1** presents each discussed impact in association with a proposed suite of impact management and mitigation measures. Each impact is then quantified using the same general methodology discussed in Section 6.3.2. The results documented in **Table 6.4-1** (along with **Table 6.3-1**) will form the basis of the first iteration of the Project's ESAR, as discussed in GG-29, "Determination of Environmental and Social Aspects and Significant Impacts" (see **Appendix 7C**). As previously noted, as the Project enters the major construction phase, the ranked risks and impacts in the initial version of the ESAR will be used as the basis for the development of periodically updated and prioritized environmental and social objectives and targets for performance improvement, as discussed in Sections 4.1 and 4.2 of the Project *ESMS Plan* and GG-30, "Environmental and Social Objectives, Targets, and Performance Improvement Program."

Because many aspects of cumulative impacts reflect external factors beyond the Project's ability to influence, and because the Project life-cycle is over 20 years long, this periodic review and update process is of particular importance in the development, implementation, and the potential modification of management and mitigation measures, to ensure their continued effectiveness in response to changing Project conditions and stakeholder interests.

6.4.2 Cumulative Impacts on the Physical and Biological Environment

The extent of the direct impacts on the terrestrial environment from the existing or historical activities in the region surrounding the Project AOI has been most pronounced in areas along streams and rivers and along access roadways, trails, and cleared areas. Cumulative impacts to the physical and biological environment are discussed in the following paragraphs:

- **Air Quality Impacts:** given the remoteness of the site, air quality impacts from non-Project sources are minimal, being limited to minor stationary or mobile motorized sources, cooking or occasional clearance fires, and rotting vegetation. The addition of round-the-clock No. 4 fuel-fired power generation facilities at the Aurora site, diesel-fired power generation at Buckhall, the operation of mine vehicles and truck convoys at Buckhall and the Aurora site and on the connecting roadways, and the delivery of materials and equipment by barge to the Buckhall wharf will constitute a marked increase in emissions over the current baseline conditions, particular during the construction phase. As noted in the assessment of impact significance for this impact in **Table 6.4-1**, these impacts will endure over the life of the mine, but will have a relatively

Table 6.4-1: Evaluation of Relative Significance of Cumulative Impacts

Aspect Category	Cumulative Aspect Description			Impact Significance Ranking with Management/ Mitigation Measures in Effect							Impact Score
	Potential Cumulative Impact	Management/Mitigation Measures	Regulated or Known Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Cumulative impacts – physical and biological environment	Air quality and GHG impacts in and around the Project’s mining license and along the access corridor to Buckhall, over and above impacts originating with ASM, legal (Barama) and illegal logging operations	• Implementation of Project <i>Air Quality Management Plan</i> for stationary and mobile motorized sources • Selection of No. 4 blended fuel for power generation (vs. heavy fuel oil) • Implementation of preventive maintenance program for all generator sets and all mobile/stationary sources • Staging of barge deliveries to Buckhall wharf to minimize potential marine source impacts • Implementation of fire prevention program per the Project <i>Occupational Health and Safety Plan</i> and GG-22, “Fire Prevention Program” • Elimination of all emissions sources upon closure	Yes	1	1	5	5	3	2	1.0	17
Cumulative impacts – physical and biological environment	Impacts on Cuyuni River water quality [e.g., Hg and petroleum hydrocarbon contamination, excessive total suspended solids (TSS) values, BOD/COD, fecal coliform] over and above accumulated historical ASM impacts and the potential impacts associated with continuing ASM and other intrusive human impacts upstream and adjacent to the Project’s mining license	• No use of Hg in mineral separation or other industrial process • Collection and controlled disposal of Hg ballast/fluorescent light waste per hazardous waste provisions of Project <i>Waste Management Plan</i> • Revegetation of Aurora (M3) extension road ROWs • Minimization of clearance actions/project footprint per the <i>Erosion Prevention and Control Plan</i>, <i>Exploration Management Plan</i>, <i>Construction Management Plan – Early Works</i>, and <i>Construction Management Plan</i> [to be developed by GGI’s EPC contractor prior to major construction] • Implementation of GIIPs in the <i>Erosion Prevention and Control Plan</i> and <i>Water Management Plan</i> to manage waste rock stockpiles, and to detect and mitigate erosional issues in other disturbed areas • Restoration and rehabilitation of any ASM areas identified in within Mining License boundaries • Implementation of appropriate progressive restoration and erosional stabilization procedures for mined-out areas of the open pits per the <i>Erosion Prevention and Control Plan</i> and <i>Mine Reclamation and Closure Plan</i> • Design culverts to accommodate natural surface water flows, per the Project <i>Erosion Prevention and Control Plan</i>; line earthworks where necessary to control flow rates/velocities and minimize erosion • Implementation of the <i>Spill Prevention, Control and Contingency Plan (Aurora Project Areas)</i> • Establishment of contractual requirements for the trucking companies transporting fuel and other hazardous chemicals to have spill contingency plans and spill kits • Establish emergency spill response stations at Tapir Crossing and other selected locations on Aurora (M3) access road extension • Placement of spill kits on all heavy equipment and passenger vehicles • Installation of diversion structures to route un-impacted surface water around mining operations, and to route potentially impacted surface water to the MWP • Construction of sedimentation ponds for waste rock stockpiles, TMA Diversion Pond 2 effluent, and MWP effluent as necessary to manage potentially excessive TSS, and implementation of other GIIPs in the <i>Erosion Prevention and Control Plan</i> and <i>Water Management Plan</i> to detect/mitigate erosion in other disturbed areas • Collection and treatment of sanitary wastewater from mineral processing/warehousing, administrative areas and Aurora man-camp facilities	Yes	1	1	1	1	4	5	x 0.1	1.3

Aspect Category	Cumulative Aspect Description			Impact Significance Ranking with Management/ Mitigation Measures in Effect							Impact Score
	Potential Cumulative Impact	Management/Mitigation Measures	Regulated or Known Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Cumulative impacts – physical and biological environment	See above	- Regular monitoring of upstream/downstream water Quality River, as well as TMA supernatant, TMA Diversion Pond/effluent, FWP, MWP effluent, wastewater treatment plant effluent, and sanitary landfill leachate water quality per <i>Water Management Plan</i> and <i>ESHS Monitoring Plan</i> - Removal of all aboveground structures, stabilization of earthworks, and rehabilitation and revegetation of impacted areas at closure and implementation of post-closure monitoring, per the final <i>Detailed Mine Reclamation and Closure Plan</i> - Regular monitoring for ASM, illegal logging, or other intrusive human activities in or adjacent to Project area per the <i>Influx Management Plan</i>, <i>Community Relations Management Plan</i>, and GG-40, “Site Security” - Regular (mine life cycle) review of noted cumulative aspect/impact and implementation of additional planning or procedural controls, modifications, or improvements as warranted, per Sections 3.2, 4.2, and 4.3 of the Project <i>ESMS Plan</i>	See above	See above	See above	See above	See above	See above	See above	See above	See above
Cumulative impacts – physical and biological environment	Impacts on biota and natural terrestrial habitat over and above accumulated historical ASM impacts and the potential for continuing ASM and other intrusive human impacts upstream and adjacent to the Project's mining license	- Prohibition on hunting, fishing, harboring of wild animals, or introduction of invasive species by the Project workforce or contractors - No use of Hg in mineral separation or other industrial process - Collection and controlled disposal of Hg ballast/fluorescent light waste per hazardous waste provisions of Project <i>Waste Management Plan</i> - Revegetation of Aurora (M3) extension road ROWs using non-invasive species - Minimization of clearance actions/project footprint per the <i>Erosion Prevention and Control Plan</i>, <i>Exploration Management Plan</i>, <i>Construction Management Plan – Early Works</i>, and <i>Construction Management Plan</i> [to be developed by GGI's EPC contractor prior to major construction] - Implementation of GIIPs in the <i>Erosion Prevention and Control Plan</i> and <i>Water Management Plan</i> to manage waste rock stockpiles, and to detect and mitigate erosional issues in other disturbed areas - Restoration and rehabilitation of any ASM areas identified in within Mining License boundaries - Implementation of appropriate progressive restoration and erosional stabilization procedures for mined-out areas of the open pits per the <i>Erosion Prevention and Control Plan</i> and <i>Mine Reclamation and Closure Plan</i> - Design culverts to accommodate natural surface water flows, per the Project <i>Erosion Prevention and Control Plan</i>; line earthworks where necessary to control flow rates/velocities and minimize erosion - Implementation of the <i>Spill Prevention, Control and Contingency Plan (Aurora Project Areas)</i>; placement of spill kits on all heavy equipment and passenger vehicles, and installation of emergency response stations at select locations along the access road - Establishment of contractual requirements for the trucking companies transporting fuel and other hazardous chemicals to have spill contingency plans and spill kits - Establish emergency spill response stations at Tapir Crossing and other selected locations on Aurora (M3) access road extension - Placement of spill kits on all heavy equipment and passenger vehicles - Installation of diversion structures to route un-impacted surface water around mining operations, and to route potentially impacted surface water to the MWP	Yes	1	1	1	1	3	5	x 0.1	1.2

Aspect Category	Cumulative Aspect Description			Impact Significance Ranking with Management/ Mitigation Measures in Effect							Impact Score
	Potential Cumulative Impact	Management/Mitigation Measures	Regulated or Known Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Cumulative impacts – physical and biological environment	See above	- Construction of sedimentation ponds for waste rock stockpiles, TMA Diversion Pond 2 effluent, and MWP effluent as necessary to manage potentially excessive TSS, and implementation of other GIIPs in the <i>Erosion Prevention and Control Plan</i> and <i>Water Management Plan</i> to detect/mitigate erosion in other disturbed areas - Collection and treatment of sanitary wastewater from mineral processing/warehousing, administrative areas and Aurora man-camp facilities - Regular monitoring of upstream/downstream water Quality River, as well as TMA supernatant, TMA Diversion Pond/effluent, FWP, MWP effluent, wastewater treatment plant effluent, and sanitary landfill leachate water quality per <i>Water Management Plan</i> and <i>ESHS Monitoring Plan</i> - Regular monitoring for ASM, illegal logging, or other intrusive human activities in or adjacent to the Project area per the <i>Influx Management Plan</i>, <i>Community Relations Management Plan</i>, and GG-40, “Site Security” - Regular (mine life cycle) review of noted cumulative aspect/impact and implementation of additional planning or procedural controls, modifications, or improvements as warranted, per Sections 3.2, 4.2, and 4.3 of the Project <i>ESMS Plan</i>	See above	See above	See above	See above	See above	See above	See above	See above	See above
Cumulative impacts – socioeconomic	Increased influx to Buckhall area, with increased potential for ASM, illegal commerce/ prostitution, and criminal activities	- Establishment of human resources policies requiring all hiring and contracting to be conducted in Georgetown, and dissemination of such information via the <i>Community Relations Management Plan</i> and other appropriate means - Establishment and enforcement of an employee code of conduct as part of the Project's Labour Grievance Procedure, including prohibitions on fighting, firearms, use or sale of alcohol or illegal drugs, engagement of prostitutes, or engagement in criminal activity - Establishment of controlled, self-contained man-camp at the Buckhall logistics support facility for all workforce and contractor accommodations - Control of all workforce transportation (and periodic convoys of materials and equipment) to and from Buckhall - Implementation of the Project <i>Influx Management Plan</i> and <i>Community Relations Management Plan</i> - Prohibition of uncontrolled contacts between the Buckhall workforce and workforce or contractors in transit to the Aurora site, with exceptions made for workers with families who are Buckhall residents - Establishment and maintenance of periodic planned contacts with the Buckhall community via the <i>Community relations Management Plan</i>, including negotiation of limited categories of legal commerce - Periodic medical awareness/treatment campaigns at Buckhall, including discussion of HIV/AIDS and transmission of STDs - Regular monitoring for illegal or intrusive human activities in and around the Buckhall community per the <i>Influx Management Plan</i>, <i>Community Relations Management Plan</i>, and GG-40, “Site Security”, and engagement of the GPF as warranted by circumstances - Regular (mine life cycle) review of noted cumulative aspect/impact and implementation of additional planning or procedural controls, modifications, or improvements as warranted, per Sections 3.2, 4.2, and 4.3 of the Project <i>ESMS Plan</i>	Yes	4	3	4	5	2	5	1.0	23

Aspect Category	Cumulative Aspect Description			Impact Significance Ranking with Management/ Mitigation Measures in Effect							Impact Score
	Potential Cumulative Impact	Management/Mitigation Measures	Regulated or Known Stakeholder issue?	Scale	Severity	Frequency	Duration	Ability to influence	Image	Probability factor (X)	
Cumulative impacts – socioeconomic	Increased influx to Aurora Mine license area, with Increased potential for ASM, illegal commerce/ prostitution, and criminal activities	- Establishment of human resources policies requiring all hiring and contracting to be conducted in Georgetown, and dissemination of such information via the <i>Community Relations Management Plan</i> and other appropriate means - Establishment and enforcement of an employee code of conduct as part of the Project's Labour Grievance Procedure, including prohibitions on fighting, firearms, use or sale of alcohol or illegal drugs, engagement of prostitutes, or engagement in criminal activity - Establishment of controlled, self-contained man-camp at the Aurora site for all workforce accommodations - Control of all workforce transportation to and from the Aurora site - Implementation of the Project <i>Influx Management Plan</i> and <i>Community Relations Management Plan</i> - Prohibition of commercial activity at the Aurora site, as well as uncontrolled contacts between workforce and ASM/transient encampments and the ASM “community” at Aranka Mouth - Establishment and maintenance of periodic planned contacts with the ASM “community” at Aranka Mouth via the <i>Community relations Management Plan</i> - Periodic medical awareness/treatment campaigns at Aranka Mouth of other locations, including discussion of human immunodeficiency virus infection / acquired immunodeficiency syndrome (HIV/AIDS) and other sexually transmitted diseases (STDs) - Regular monitoring for ASM, illegal logging, or other intrusive human activities in or adjacent to Project areas per the <i>Influx Management Plan</i>, <i>Community Relations Management Plan</i>, and GG-40, “Site Security”, and engagement of the GPF as warranted by circumstances - Regular (mine life cycle) review of noted cumulative aspect/impact and implementation of additional planning or procedural controls, modifications, or improvements as warranted, per Sections 3.2, 4.2, and 4.3 of the Project <i>ESMS Plan</i>	Yes	3	3	3	5	3	5	1.0	22
Cumulative impacts – socioeconomic	Increased access to interior regions by extension of Barama(M3) road to Tapir Crossing and Aurora site	- Monitoring of ASM or other incursions and engagement of GPF and GFC, as appropriate, per <i>Influx</i> - Regular monitoring for ASM, illegal logging, or other intrusive human activities in or adjacent to Project area per the <i>Influx Management Plan</i>, <i>Community Relations Management Plan</i>, and GG-40, “Site Security”, and engagement of the GPF as warranted by circumstances - Prohibition of non-Project use of Tapir Crossing ferry boats or other Project work boats except in medical or humanitarian emergencies - Prohibition of non-Project use of the Aurora airstrip and chartered aircraft except in medical or humanitarian emergencies - Regular (mine life cycle) review of noted cumulative aspect/impact and implementation of additional planning or procedural controls, modifications, or improvements as warranted, per Sections 3.2, 4.2, and 4.3 of the Project <i>ESMS Plan</i>	Yes	3	2	3	5	3	3	1.0	19

low scale and severity due to the remoteness of the project and the anticipated effectiveness of the noted management and mitigation measures. This impact is also temporary, as it will disappear with the elimination of all emissions sources at Project closure.

- Water quality and aquatic habitat impacts:** the extent of the direct impacts on the terrestrial environment from the existing or historical activities in the region has been relatively limited to areas along streams and rivers and along access roadways, trails, and cleared areas. As noted in Section 4 of this updated ESIA, the impacts on water quality and aquatic habitats from many decades of ASM in the Cuyuni Basin are particularly far-reaching, due to the release of sediments and other contaminants (e.g., mercury, petroleum hydrocarbons) to surface waters as far upstream as Venezuela. It is fundamentally important that the Project not contribute to the worsening of water quality and aquatic habitats that are already significantly degraded, and as shown in **Table 6.4-1**, a substantial number of management and mitigation measures have been devised to achieve that end. No significant cumulative impacts on aquatic environments are predicted from the Project given that direct impacts will be limited largely to the boundaries of the Project footprint. The Project is specifically designed to avoid discharges of sediments, contaminated waters, or toxic substances to the Cuyuni River or its tributaries. The greater portion of the cumulative impacts are expected to be associated with ASM and other intrusive human activities, hence a number of the proposed mitigation measures involve monitoring for any increases of such activities, which will trigger intervention, to the extent possible, in compliance with the *Project's Influx Management Plan* and *Community Relations Management Plan*. As shown in **Table 6.4-1**, impact scale, severity, frequency, and duration of the cumulative impact is expected to be minimal after implementation of management/mitigation measures; GGI does have a significant amount of control over its own potential impacts, however, and it is recognized that strong performance in this area is critical in terms of public/stakeholder perception.
- Impacts on biota and terrestrial habitat:** as previously noted, the extent of direct impacts on the terrestrial environment from the existing or historical activities has been relatively limited to areas along streams and rivers and along access roadways, trails, and cleared areas. However, as noted in Section 4, while the forest cover remains relatively intact, terrestrial wildlife populations have been significantly affected by many decades of ASM, hunting, logging, and other intrusive human activity. Given that no new roads will be opened between Buckhall and the beginning other Aurora (M3) extension road just north of Tapir Crossing, no significant incremental impacts on biodiversity from increased human accessibility is expected. With respect to the road extension to Tapir Crossing and west to the Aurora site, access to this section of road will be controlled and monitored by GGI and no significant cumulative impacts are anticipated. This area was already accessible from the Cuyuni River and by ASM trails prior to the construction of the road. It should be noted that Barama has logging rights in areas to the south of the Cuyuni River, and GGI is obliged permit access from the new road extension, for these purposes. However, GGI will control and monitor access to and use of the road and

report any illegal activities to proper authorities as per the *Biodiversity Management Plan*, *Influx Management Plan* and *Community Relations Management Plan*.

The Project footprint is not significant with respect to the scale of the habitats, ecosystems, or species ranges of the region, and the progressive restoration of the mine will ensure the long-term recovery of ecological processes; thus, the impacts of conversion of soils and habitats loss within the Project footprint will not contribute significantly to cumulative impacts in the lower Cuyuni basin. As part of its goal of achieving no net loss of natural habitats, the Project will also assist with the rehabilitation of habitats degraded by historical artisanal and small-scale mining (ASM) within the Project's mine license area.

6.4.3 Cumulative Socioeconomic Impacts

The potential cumulative socioeconomic impacts likely to result from the Project are limited to a significant degree by the limited population in the Project's direct and indirect social AOIs, as noted in Section 5.4 of this updated ESIA. Within the Project's direct AOI, the Buckhall and Aranka Mouth areas have very small populations. The nearest Amerindian village (Kurutuku) is upstream of the "Devil's Hole" rapids on the Cuyuni River and has more socioeconomic linkages with Venezuela than it does with downstream areas in Guyana. The population distribution also reflects certain tendencies of Guyanese society, such as a preference (for most Guyanese) for living in the coastal plain region and general aversion to the difficulties of a "bush" lifestyle. It may be observed that the development of the ASM activities over the past 40+ years has not led to the development of major permanent settlements, or to the expansion of the "agricultural frontier" in the Cuyuni Basin, as is sometimes seen in other regions of South America.

Cumulative socioeconomic impacts are discussed in the following paragraphs:

- Increased influx to the Buckhall area;** In Buckhall, as well as the Parika and Georgetown areas, the incremental effects of the Project on socioeconomic conditions will be contingent upon the dynamics of the local economic activities. Over the course of the Project's lifetime, the cumulative socioeconomic impact is expected to be strongly positive, potentially generating sources of income and revenues for local workers, providers of goods and services, and indirect activities. However, such positive benefits will only last as long as the life of the mine, and must be carefully coordinated within the context of the *Influx Management Plan* and *Community Relations Management Plan* in order to minimize the potential for increased ASM activities, as well as illegal commerce, prostitution, and other criminal activities, as well as potential discontent related to with the inevitable economic downturn that will occur as the Project enters the decommissioning and closure phase. As noted in **Table 6.4-1**, although a range of appropriate management and mitigation practices have been identified, the estimated scale, severity, frequency, and duration of influx-related impacts are predicted, with reasonable certainty, to persist over the lifetime of the project. Careful and consistent implementation of the proposed management and mitigation measures will be required, along with periodic adjustments to meet changing stakeholder needs over the Project lifetime.

- Increased influx to the Aurora Mine license area and lower Cuyuni River basin;*** the Project is not anticipated to have a significant incremental effect on influx to the lower Cuyuni basin, for a number of reasons. First, during the course of exploration activities, prospective job seekers from Georgetown, or other population centers have not appeared at the Aurora site, because GGI has effectively communicated that that all hiring is to be done in Georgetown, not onsite. Second, no informal commercial activities have been established near the Aurora site during the exploration phase or early works construction, because workers are not permitted to engage in any sort of interaction with transient groups or informal communities outside of an established man-camp under GGI control. Influx to the lower Cuyuni has been driven largely by ASM, independent of Project exploration or early works construction activities. The progression of the Project from exploration to major construction and mining operations is not expected to change the current situation. In addition, the existing Barama (M3) road is not being used as a colonization corridor, as might be expected in some other parts of South America with traditions of expanding agricultural frontiers along road networks. The forested lands of the region are not valued as potential farmland by the Guyanese, and agricultural activities are typically concentrated in the coastal plains. There is little incentive or motivation for urban residents to move into the lower Cuyuni basin in the absence of significant new economic opportunities. Thus, the construction, operation, closure, and post-closure phases of the Project are not likely to have any significant cumulative impact. This being said, the potential for sporadic ASM contacts and interest in or near the Aurora site is likely to persist over the life of the project. Maintaining contact with this transient community through periodic contacts with the informal ASM community at Aranka Mouth will be critical to maintaining an understanding of ASM trends and issues in the area of the Project. As is the case for Buckhall, consistent implementation of the proposed management and mitigation measures will be required, and periodic adjustments may be needed to address changing stakeholder needs over the life of the Project.

It may also be noted that any cumulative impacts of the Project on the national economy of Guyana are essentially related to changes in the volumes of jobs, income, taxes, and royalties in relation to other national sources of income that may occur over the lifetime of the Project. The Project may lead to increases in income and revenues during the construction and operation phase; these will be reduced during Project closure and post-closure. Employment and royalties may also be affected by fluctuations in commodity prices that are beyond GGI's control. The relative contribution of the Project to the national economy will be inversely related to the number of other major mining-sector projects or other economic developments that may be developed over the Project's lifetime. The circumstances of workers during retrenchment will be partially determined by the future availability of other jobs and economic opportunities in the country, which are factors largely beyond the control of the Project. However, GGI will provide retrenchment compensation as mandated by Guyanese labor laws, and, if mining sector jobs are not available at the time of closure, will also provide diversified skills training to build capacities of former workers and service providers to find economic opportunities with other industries in Guyana. Workers' families and Amerindian communities will be preferentially targeted for potential income generation projects, and selected public/community development

projects will be implemented via the *Community Relations Management Plan*. Taken collectively, these actions are expected to minimize the adverse impacts of retrenchment.

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Section 7:
Assessment and Management Environmental
and Social Risks (Ref: IFC PS1)

7	Assessment and Management of Environmental and Social Risks and Impacts (Ref: IFC PS 1)	7-2
7.1	Summary of PS 1 Requirements	7-2
7.2	Project ESMS Description	7-2
7.2.1	ESMS Plan	7-9
7.2.2	Management and Mitigation Plans	7-9
7.2.3	Standard Operating Procedures	7-16

List of Figures

Figure 7.3-1: ESMS Document Hierarchy

List of Tables

Table 7.1-1: References for ESMS Management Plan Structure and Content

Table 7.2-1: Management Plan Applicability over Mine Life Cycle

Table 7.3-1: Standard Operating Procedures

List of Appendices

Appendix 7A: Environmental and Social Management System (ESMS) Plan

Appendix 7B: Management Plans

Appendix 7C: Standard Operating Procedures

7 Assessment and Management of Environmental and Social Risks and Impacts (Ref: IFC PS 1)

7.1 Summary of PS 1 Requirements

Performance Standard (PS) PS 1, “Assessment and Management of Environmental and Social Risks and Impacts”¹ PS establishes Environmental and Social Management System (ESMS) requirements for all projects that have environmental and social risks and impacts. PS 1 includes specific requirements for public consultation and disclosure, including the establishment of appropriate grievance mechanisms, and underscores the International Finance Corporation’s (IFC’s) interest in ensuring that the project proponent systematically identifies and effectively manages the environmental and social risks and impacts that may occur over the life of a project. Where ESMS requirements are concerned, PS 1 draws on well-established and internationally recognized continuous improvement-based (i.e., “plan, do, check, act”) management processes, and provides a structured and methodical approach for managing environmental and social risks and associated impacts, on an ongoing basis. ESMSs based on similar processes have been widely and successfully implemented within the international mining industry, and have proved to be an important component in achieving more balanced and sustainable financial, social, and environmental outcomes in major mining projects.

The stated objectives of PS 1 are to:

- identify and assess the environment and social risks and impacts of the project;
- adopt a mitigation hierarchy to avoid (or where avoidance is not possible, minimize, mitigate, compensate for, or offset) adverse impacts on workers, affected communities, and the environment;
- promote improved environmental and social performance of on the part of the project proponent, through the development and implementation of effective management systems;
- ensure that potential grievances and other communications from affected communities are evaluated, and appropriately and systematically addressed; and
- ensure that affected communities are appropriately engaged on environmental and social issues that could potentially affect them, over the entire project life cycle.

7.2 Project ESMS Description

GGI has developed a documented ESMS for the Aurora Gold Project (Project) that is designed to comply with the requirements of IFC PS 1. As noted in **Table 7.2-1**, in addition to the requirements of PS-1, the Project *ESMS Plan* also incorporates applicable elements of:

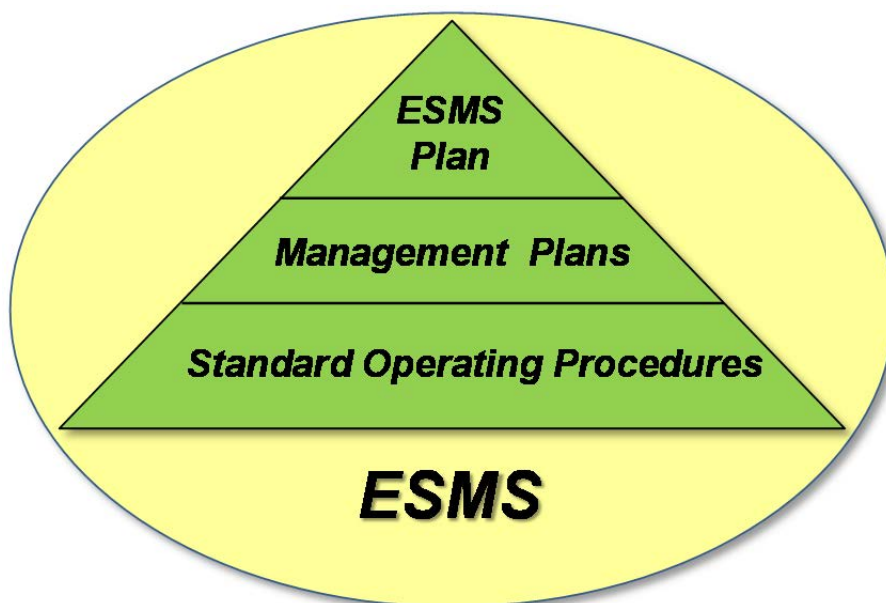
¹ See http://www1.ifc.org/wps/wcm/connect/c8f524004a73daeca09afdf998895a12/IFC_Performance_Standards.pdf?MOD=AJPERES

- the relevant IFC Environmental, Health, and Safety (EHS) Guidelines (i.e., General, EHS guidelines plus the Industry Sector Guidelines for Mining and Toll Roads)² and other IFC guidance documents and good international industry practices (GIIPs) as referenced therein;
- the ISO 14001 environmental management system standard³; and
- the OHSAS 18001⁴ occupational health and safety (OHS) management system standard.

These standards have been widely and successfully applied by the international mining industry and collectively provide an appropriate basis for the development of an effective, fully integrated ESMS capable of addressing applicable Guyanese regulatory requirements as well as meeting good international industry practices (GIIP) for the management of the environmental, health and safety, and social aspects of mining project operations.

The overall hierarchy of documents that comprise the ESMS is depicted in **Figure 7.2-1**.

Figure 7.2-1: ESMS Document Hierarchy



² See

http://www1.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/IFC+Sustainability/Sustainability+Framework/Environmental,+Health,+and+Safety+Guidelines/

³ ISO 14001:2004, *Environmental management systems – Requirements with Guidance for Use*; International Organization for Standardization, Geneva, Switzerland, 2004. ISO 14001 is considered as a GIIP only and this reference should not be construed as a commitment to undertake third-party certification.

⁴ OHSAS 18001:2007, *Occupational health and safety management systems – Specification*; OHSAS Project Group Secretariat, London, United Kingdom 2007. OHSAS 18001 is selected as a GIIP for OHS program management, as well as for its structural and contextual compatibility with PS 1 and ISO 14001. References to this standard should not be construed as a commitment to undertake third-party certification.

Table 7.2-1: ESMS Plan– References for Structure and Content

<i>ESMS Plan Sections/Subsections</i>	<i>Applicable IFC Performance Standard 1 Requirements⁵</i>	<i>Applicable IFC Mining Guidance Requirements⁶</i>	<i>Corresponding ISO 14001:2004 requirements</i>	<i>Corresponding OHSAS 18001:2007 requirements</i>
1.0 INTRODUCTION				
1.1 ESMS Description	• Requirements, item 4 and 5, pp.-6-7	N/A	4.1	4.1
1.2 ESMS Documentation	• Requirements, item 5, p. 7	N/A	4.5	4.5
1.3 Change Management	• Requirements, item 5, p. 7	N/A	4.5	4.5
2.0 POLICY	• Requirements, item 6. pp. 7	N/A	4.2	4.2
3.0 IDENTIFICATION OF RISKS AND IMPACTS				
3.1 Legal and Other Requirements	• Requirements, item 7. pp. 7-8	N/A	4.3.2	4.3.2
3.2 Environmental and Social Aspects and Impacts, Risk Assessment, and Risk Management Planning	• Requirements, items 7-12, pp. 7-9	• Section 1.1, “Environmental (Impacts and Management)” • Section 1.3, “Community Health and Safety (Impacts and Management)”	4.3.1	N/A
3.3 Occupational Health and Safety Hazard Identification, Risk Assessment, and Risk Management Planning	• Requirements, items 7-12, pp. 7-9	• Section 1.2, “Occupational Health and Safety (Impacts and Management)” • Section 1.3, “Community Health and Safety (Impacts and Management)”	N/A	4.3.1

⁵ (IFC, 2007c); see http://www1.ifc.org/wps/wcm/connect/c8f524004a73daeca09afdf998895a12/IFC_Performance_Standards.pdf?MOD=AJPERES

⁶ The relevant requirements of the IFC *General EHS Guidelines* (IFC, 2007a) and *EHS Guidelines for Toll Roads* (IFC, 2007b) will also be considered within the structural context presented in column 1 of this table.

<i>ESMS Plan Sections/Subsections</i>	<i>Applicable IFC Performance Standard 1 Requirements⁵</i>	<i>Applicable IFC Mining Guidance Requirements⁶</i>	<i>Corresponding ISO 14001:2004 requirements</i>	<i>Corresponding OHSAS 18001:2007 requirements</i>
4.0 MANAGEMENT PROGRAMS				
4.1 Environmental, Social and Health & Safety (ESHS) Objectives and Targets	Requirements, items 13 - 16. pp. 9-10	- Section 1.1, "Environmental (Impacts and Management)" - Section 1.2, "Occupational Health and Safety (Impacts and Management)" - Section 1.3, "Community Health and Safety (Impacts and Management)" - Section 2.1, "Environment (Performance Indicators and Monitoring)" - Section 2.2, "Occupational Health and Safety (Performance Indicators and Monitoring)"	4.3.3	4.3.3
4.2 ESHS Performance Improvement Management Program/Management Plans	Requirements, items 13 - 16. pp. 9-10	- Section 1.1, "Environmental (Impacts and Management)" - Section 1.2, "Occupational Health and Safety (Impacts and Management)" - Section 1.3, "Community Health and Safety (Impacts and Management)" - Section 2.1, "Environment (Performance Indicators and Monitoring)" - Section 2.2, "Occupational Health and Safety (Performance Indicators and Monitoring)"	4.3.4	4.3.4
4.3 Operational Control				
4.3.1 Operational Planning Process	Requirements, items 13 - 16. pp. 9-10	- Section 1.1, "Environmental (Impacts and Management)" - Section 1.2, "Occupational Health and Safety (Impacts and Management)" - Section 1.3, "Community Health and Safety (Impacts and Management)"	4.4.6	4.4.6

<i>ESMS Plan Sections/Subsections</i>	<i>Applicable IFC Performance Standard 1 Requirements⁵</i>	<i>Applicable IFC Mining Guidance Requirements⁶</i>	<i>Corresponding ISO 14001:2004 requirements</i>	<i>Corresponding OHSAS 18001:2007 requirements</i>
4.3.2 Management of Environmental and Social Impacts	Requirements, items 13 - 16. pp. 9-10	- Section 1.1, "Environmental (Impacts and Management)" - Section 1.3, "Community Health and Safety (Impacts and Management)"	4.4.6	N/A
4.3.3 Control of Contractor Operations	Requirements, item 14, pp. 9-10	- Section 1.1, "Environmental (Impacts and Management)" - Section 1.2, "Occupational Health and Safety (Impacts and Management)" - Section 1.3, "Community Health and Safety (Impacts and Management)"	4.4.6	4.4.6
5.0 ORGANIZATIONAL CAPACITY AND COMPETENCY				
5.1 Structure and Responsibility	Requirements, items 17 - 19. pp. 10-11	N/A	4.1	4.1
5.2 Training, Awareness, and Competence	Requirements, items 17 - 19. pp. 10-11	Section 1.2, "Occupational Health and Safety (Impacts and Management)"	4.2	4.2
6.0 EMERGENCY PREPAREDNESS AND RESPONSE				
(No subheading) EMERGENCY PREPAREDNESS AND RESPONSE	Requirements, items 20 - 21, p. 11	- Section 1.1, "Environmental (Impacts and Management)" - Section 1.2, "Occupational Health and Safety (Impacts and Management)" - Section 1.3, "Community Health and Safety (Impacts and Management)"	4.4.7	4.4.7
7.0 MONITORING AND REVIEW				
7.1 ESMS Records	N/A	N/A	4.5.3	4.5.3

<i>ESMS Plan Sections/Subsections</i>	<i>Applicable IFC Performance Standard 1 Requirements⁵</i>	<i>Applicable IFC Mining Guidance Requirements⁶</i>	<i>Corresponding ISO 14001:2004 requirements</i>	<i>Corresponding OHSAS 18001:2007 requirements</i>
7.2 Monitoring and Measurement				
7.2.1 ESHS Monitoring	Requirements, items 22 - 24, pp. 11-12	- Section 2.1, "Environment (Performance Indicators and Monitoring)" - Section 2.2, "Occupational Health and Safety (Performance Indicators and Monitoring)"	4.5.1	4.5.1
7.1.2 Regulatory Compliance Verification Audits	Requirements, items 22 - 24, pp. 11-12	- Section 2.1, "Environment (Performance Indicators and Monitoring)" - Section 2.2, "Occupational Health and Safety (Performance Indicators and Monitoring)"	4.5.1	4.5.1
7.2.3 ESHS Performance Measurements	Requirements, items 22 - 24, pp. 11-12	- Section 2.1, "Environment (Performance Indicators and Monitoring)" - Section 2.2, "Occupational Health and Safety (Performance Indicators and Monitoring)"	N/A	4.5.1
7.3 Non-conformance Reporting and Corrective and Preventive Action	Requirements, items 22 - 24, pp. 11-12	N/A	4.5.2	4.5.2
7.4 Internal ESHS Management System Audits	Requirements, items 22 - 24, pp. 11-12	N/A	4.5.4	4.5.4
7.5 Management Review	Requirements, items 22 - 24, pp. 11-12	N/A	4.6	4.6
8.0 STAKEHOLDER ENGAGEMENT				
8.1 Stakeholder Analysis and Engagement Planning	Requirements, items 26-28. p. 13	Section 1.3, "Community Health and Safety (Impacts and Management)"	4.3.3	4.3.3
8.2 Disclosure of Information	Requirements, items 29, p. 13	Section 1.3, "Community Health and Safety (Impacts and Management)"	4.3.3	4.3.3

<i>ESMS Plan Sections/Subsections</i>	<i>Applicable IFC Performance Standard 1 Requirements⁵</i>	<i>Applicable IFC Mining Guidance Requirements⁶</i>	<i>Corresponding ISO 14001:2004 requirements</i>	<i>Corresponding OHSAS 18001:2007 requirements</i>
8.3 Consultation	Requirements, items 30, p. 813	Section 1.3, "Community Health and Safety(Impacts and Management)"	4.3.3	4.3.3
8.4 Informed Consultation and Participation	Requirements, items 31, p. 13	Section 1.3, "Community Health and Safety(Impacts and Management)"	4.3.3	4.3.3
8.5 Indigenous Peoples	Requirements, items 32, p. 14	Section 1.3, "Community Health and Safety(Impacts and Management)"	4.3.3	4.3.3
8.6 Private Sector Responsibilities under Government-Led Stakeholder Engagement	Requirements, items 33, p. 14	Section 1.3, "Community Health and Safety(Impacts and Management)"	4.3.3	4.3.3
9.0 EXTERNAL COMMUNICATIONS AND GRIEVANCE MECHANISMS				
9.1 External Communications	Requirements, items 34, p. 15	Section 1.3, "Community Health and Safety(Impacts and Management)"	4.3.3	4.3.3
9.2 Grievance Mechanism for Affected Communities	Requirements, items 35, p. 15	Section 1.3, "Community Health and Safety(Impacts and Management)"	4.3.3	4.3.3
10.0 ONGOING REPORTING TO AFFECTED COMMUNITIES	Requirements, items 36, p. 15	Section 1.3, "Community Health and Safety(Impacts and Management)"	4.3.3	4.3.3

The functions fulfilled by each level of ESMS documentation are summarized in paragraphs 7.2.1 through 7.2.3 below.

7.2.1 ESMS Plan

The **ESMS Plan** developed for the Project incorporates GGI's human resources, community relations, and EHS policy statements. It describes the overall structure, requirements, and content of the ESMS, as well as the organizational structure, key management responsibilities, and the specific functions fulfilled by other ESMS documents. The first iteration of the *ESMS Plan* is included for reference in **Appendix 7A** of this ESIA. It includes procedures for the assessment and continuing reassessment of environmental and social risks and impacts, and the management and mitigation of such impacts. It also provides procedures for responding to labor and environmental/community grievances, which were separately approved by IFC during the exploration phase of the Project. The plan is designed to be periodically reviewed and updated in response to the changes that will occur in various phases of the Project life cycle. It is the primary reference for the overall design and contents of the ESMS and is meant to serve as a key communication tool in the presentation of the ESMS to lenders, regulatory authorities, and other external parties.

7.2.2 Management and Mitigation Plans

The *ESMS Plan* will be supported by a suite of management plans, which will be focused on the management or mitigation of the specific environmental and social issues or impacts generally associated with one or more phases of the Project. A conceptual list of the management plans likely to be required over all phases of the Project and their general applicability during each phase is presented in **Table 7.2-2**. As noted in the table, 14 plans will be developed to support the ESMS and implemented as the Project transitions from the exploration/early works construction phase to the major construction phase. Conceptual drafts of these first 14 plans are provided for reference in **Appendix 7B** of this ESIA. The general scope and purpose of each of these plans are briefly summarized as follows:

- **Exploration Management Plan:** This plan will address the management of the limited range of environmental and social issues associated with reconnaissance visits to various Project areas by small field teams, in order to locate geological features that merit more detailed geological investigations for the characterization of mineral resources with extractive potential. The plan will also describe the management of access roads to drilling pad locations, the construction and operation of temporary camps, subsurface drilling operations, borehole closure, and drill pad cleanup and restoration. As an aside, it should be noted this plan will also be applied to the management of adjacent exploration concessions outside the boundaries of the Project that may also be held by GGI.
- **Early Works Construction Management Plan:** This plan will address the management of environmental and social issues associated with a limited range of GGI construction activities (e.g., construction of core storage facilities, new man-camp facilities, temporary

Table 7.2-2: Management Plan Applicability over Project Life Cycle

Management Plan Title	Exploration/ Early Works Construction⁷	Construction	Mining Operations	Decommissioning, Site Restoration, and Closure	Post-Closure
<i>Exploration Management Plan</i>					
<i>Early Works Construction Management Plan</i>					
<i>Construction Management Plan – Major Construction</i>					
<i>Blasting Management Plan</i>					
<i>Overburden Management Plan</i>					
<i>Erosion Prevention and Control Plan</i>					
<i>Water Management Plan</i>					
<i>Annual Mining Plan</i>					
<i>Mill/Leach Plant Operations Plan</i>					
<i>Buckhall Site Operations Plan</i>					
<i>Tailings Area Management Plan</i>					
<i>Occupational Health and Safety/Accident Prevention Plan</i>					
<i>Emergency Preparedness and Response Plan</i>					
<i>Cyanide Management Plan</i>					
<i>Hazardous Materials Management Plan</i>					
<i>Spill Prevention, Control, and Contingency Plan (Aurora)</i>					
<i>Buckhall Spill Contingency Plan</i>					

⁷ Conceptual drafts of each management plan highlighted in this column are provided for reference in **Appendix 7B** of this ESIA.

Management Plan Title	Exploration/ Early Works Construction⁷	Construction	Mining Operations	Decommissioning, Site Restoration, and Closure	Post-Closure
<i>Transportation Management Plan</i>					
<i>Waste Management Plan</i>					
<i>Air Quality Management Plan</i>					
<i>Noise & Vibration Management Plan</i>					
<i>Biodiversity Management Plan</i>					
<i>Mine Reclamation and Closure Plan</i>					
<i>Community Relations Management Plan</i>					
<i>Influx Management Plan</i>					
<i>ESHS Monitoring Plan</i>					

fuel/lubricant storage facilities, water treatment plants, connecting roadways) that will be required prior to the major construction of the major components of the operating mine [e.g., the mine pit, mill, process plant, mine water pond (MWP), Fresh Water Pond (FWP) and the Tailings Management Area (TMA)].

- **Construction Management Plan:** This plan will be developed by GGI's engineering, procurement, and construction (EPC) contractor and will describe the overall organization and management of the major construction phase of the Project, from initial earthworks through the construction and commissioning of the power plant, fuel storage areas, workshops and warehouses, mill and processing plant, TMA, waste rock stockpiles, airstrip, man-camp, MWP, waste management facilities, roadways, and other infrastructure.
- **Blasting Management Plan:** This plan will be prepared by GGI's blasting contractor and/or blasting engineer prior to the Project's operational phase and will describe the safe transportation, storage, handling, and routine use of blasting agents and initiators in the excavation of the open pit and underground mine.
- **Overburden Management Plan:** This plan will be developed with EPC contractor support and will include requirements for weekly inspections of stockpile runoff water quality and the geotechnical stability of waste rock/overburden stockpiles, as well as pH in toe drain water in order to detect the potential development of acid rock drainage (ARD) conditions. The *Overburden Management Plan* will also contain a section that addresses the stockpiling and management of topsoil and mulch to support progressive and final site reclamation activities.
- **Erosion Prevention and Control Plan:** This plan will be applied to all areas (apart from the TMA, which will be managed separately) that are disturbed by mining or support operations and that are susceptible to erosion. This will include regular monitoring of diversionary structures, access and haul road rights of way (ROWs), the Aurora site airstrip and safety clearance, and other recently reclaimed or disturbed areas. Monitoring will be conducted to detect erosional conditions or turbid runoff that could impact local streams or tributaries of the Cuyuni River and the implementation of various appropriate mitigation measures or GIIP as the situation may require.
- **Water Management Plan:** With engineering contractor support, GGI will develop and maintain a probabilistic water balance model and monitoring program for the construction and operation of the TMA and other water management structures [e.g., the FWP, MWP, sedimentation ponds for the waste rock stockpiles, process plant emergency pond]. Water levels and meteorological data will be monitored to ensure that required design freeboards are maintained. Seepage, reclaim, and effluent water quality will also be monitored in order to ensure that any controlled discharges remain within the effluent discharge guidelines and/water quality standards defined by the Guyana Environmental Protection Agency (Guyana EPA) and (IFC, 2007c). The plan will also guide the implementation of any required mitigation measures.
- **Annual Mining Plan:** In the operational phase of the Project, GGI will prepare and update an annual mining plan that projects anticipated developments of the open pit and

underground mine operation, including estimation of ore production and overburden stockpiling needs and the introduction of paste backfill in the underground at the appropriate years of operation.

- **Mill/Leach Plant Operations Plan:** At the completion of the construction phase, the EPC contractor and responsible process engineering contractors will prepare standard operations and maintenance plans as part of the commissioning of the power plant, crusher, mill, and mineral extraction/detoxification plant. These plans will form the basis of a compiled plan for routine facility operations by GGI staff.
- **Buckhall Site Operations Plan:** This plan will describe the day-to-day operations of the Buckhall landing and logistics center during the construction and operational phase of the Project, as well as the operation of the ferry at Tapir Crossing.
- **Tailings Area Management Plan:** This plan will address the day-to day management of the TMA, including freeboard measurements and inspections of the integrity of the tailings and reclaim water return pipelines, as well as inspection of the geotechnical stability of all embankments, dams, diversionary and spillway structures, and other earthworks. Reclaim water quality will also be monitored on a routine basis, as well as seepage and discharge water quality to ensure that it remains within the discharge guidelines and/or water quality standards defined by the Guyana EPA and (IFC, 2007c). The plan will also guide the implementation of any required mitigation measures.
- **Occupational Health and Safety/Accident Prevention Plan:** This plan will address all aspects of OHS on the Project, with emphasis on the identifying required safety behaviors, preventive/ protective measures, and the routine implementation of standard operating procedures (SOPs) to minimize the potential for accidents, injuries, and illness within the GGI and contractor workforce.
- **Emergency Preparedness and Response Plan:** This plan will be designed to minimize the potential for accidents and emergency situations involving the exploration or construction operations, and/or the mine's physical structures or operational practices. The *Emergency Preparedness and Response Plan* will require input from the EPIC contractor, and will address the minimum geotechnical safety requirements of (IFC, 2007c), as well as GIIPs drawn from *APELL for Mining: Guidance for the Mining Industry in Raising Awareness and Preparedness for Emergencies at Local Level* (UNEP, 2001) and other appropriate sources.
- **Cyanide Management Plan:** GGI will develop and maintain a comprehensive *Cyanide Management Plan* based on the International Cyanide Management Code (ICMC)⁸ that addresses all aspects of sodium cyanide reagent procurement, transportation, and management. The *Cyanide Management Plan* will reference applicable operations and maintenance manuals for the specific inspection and preventive maintenance protocols applicable to the cyanide receiving area; cyanide storage and leach tanks and secondary containment structures; process and detoxification plant areas; and tailings and reclaim water pipelines. The *Cyanide Management Plan* will also cross-reference the *Tailings*

⁸ See http://www.cyanidecode.org/pdf/9_GoldMiningProtocol.pdf.

Area Management Plan for the routine physical inspection of all TMA earthworks and spillway structures for erosional integrity, and the proper function of the reclaim water barge and pumpback system. It will cross-reference procedures in the *Water Management Plan* for the ongoing monitoring of freeboard levels in the TMA, as well as downgradient effluent, seepage collection system, monitoring well, and surface water sampling protocols. It will also contain provisions for monitoring wildlife mortality and provide appropriate cross-references to the *Mine Reclamation and Closure Plan* (for the decommissioning and closure of cyanide facilities); the *Hazardous Materials Management Plan*; the *Spill Prevention, Control, and Contingency Plan (Aurora)*; the *Community Relations Management Plan*; and other appropriate ESMS documents as required to demonstrate full compliance with the ICMC.

- **Hazardous Materials Management Plan:** The *Hazardous Materials Management Plan* will contain requirements for weekly inspections of containment integrity, management of accumulated precipitation, segregation of incompatible chemicals, the condition of warning or access control signage, and the functionality or readiness of personal protective equipment and fire suppression and other emergency systems.
- **Spill Prevention, Control, and Contingency Plan (Aurora):** This plan will contain requirements for periodic inspections of storage and containment areas for fuel and non-cyanide reagents and other hazardous materials. Inspections will address storage area containment integrity, management of accumulated precipitation, and the functionality or readiness of personal protection equipment, fire suppression systems or equipment, and other emergency systems.
- **Buckhall Spill Contingency Plan:** This plan is designed specifically to minimize the potential for spills of fuel received at the Buckhall barge terminal and fuel trestle, and temporarily stored in the associated fuel storage tanks/logistics support area; guidance is also provided on appropriate actions to take if spillage were to occur.
- **Transportation Management Plan:** This plan addresses the management of truck/convoy traffic on the Buckhall to Project site road, as well as charter aircraft travel to and from the Project airstrip and GGI staff travel to Project sites via crew bus or light vehicles originating in Georgetown. The plan will address rules of the road, travel security, monitoring for erosional damage and illegal or undesirable human influx into the Project concessions, sharing of maintenance responsibilities with other road users, and other requirements.
- **Waste Management Plan:** This plan will provide for monitoring the accumulation and disposal of containerized hazardous waste and medical waste; the accumulation and disposal of nonhazardous waste; daily cover of temporary landfills and (when completed) the Buckhall and Project municipal landfills; and monthly sampling for landfill leachate quality. The waste management plan will also include requirements for periodic inspections to ensure the erosional stability of the landfill earthworks.
- **Air Quality Management Plan:** This plan will require visual monitoring of roadway dust generation (at the Aurora and Buckhall sites and the Tapir ferry crossing) in dry seasons, as the basis for a dust suppression program using water and/or appropriate nontoxic surfactants. The *Air Quality Management Plan* will also establish minimum requirements

for an initial ambient workplace air quality survey in the vicinity of the pit and process plant, as well as the underground mine in later phases of mine operation.

- **Noise and Vibration Management Plan:** This plan will require the routine monitoring of the noise and vibration associated with blasting operations in the operations phase and provide data back to the Project blasting engineer for use in improving the efficiency of blasting operations. Ambient workplace noise will be monitored near drilling and loading operations, heavy vehicles, the mill and power plant, and other noise-generating areas of operation, as the basis for designation of hearing protection zones for workers.
- **Biodiversity Management Plan:** This plan will require rapid surveys of flora and fauna (dry season/ wet season, at least every five years) to monitor potential changes to the biodiversity profile of the Project in the operational phase. It will also require ongoing monitoring for the presence of key indicator/potentially endangered species which may require adjustments in operating practices or other measures to protect affected habitat or otherwise minimize potential impacts. The *Biodiversity Management Plan* will also incorporate the *Erosion Prevention and Control Plan* by reference for the detection and mitigation of erosional conditions that could reduce or degrade specific habitats.
- **Mine Reclamation and Closure Plan:** This plan will include specific requirements for monitoring pit lake filling as well as the completeness of required demolition or removal actions and effectiveness of the restoration and revegetation of the reclaimed overburden/waste rock stockpiles, municipal waste landfills, MWP, TMA, the Cuyuni dike areas, roadway ROWs, and other reclaimed areas of the project. Specific erosional issues associate with closed areas will be monitored (and if necessary, remediated) in compliance with the *Erosion Prevention and Control Plan*, which will be incorporated by reference. The potential decommissioning and closure considerations for Project infrastructure at Tapir Crossing and Buckhall will also be addressed, given GGI's current understanding of regulatory and stakeholder needs and interests.
- **Community Relations Management Plan:** This plan describes the methods GGI will use to engage the workforce, local communities, and other potential stakeholders directly affected by the Project, and to ensure that relevant environmental and social information is disclosed and disseminated through appropriate outreach and communications procedures.
- **Influx Management Plan:** This plan addresses specific concerns expressed by the government of Guyana on minimizing the potential for uncontrolled influx of people to the project area, especially during mine construction and operations, and provides specific strategies and procedures for achieving those ends based on applicable IFC and United Nations (UN) guidance.
- **Environmental Social and Health and Safety (ESHS) Monitoring Plan:** This plan will be designed to comprehensively capture all of the specific monitoring needs identified in this ESIA, as well as individual management plans and supporting SOPs); it will provide for the development and maintenance of a spreadsheet documenting the planning, execution, and reporting actions associated with the environmental and social monitoring requirements that will apply over the construction, operation, decommissioning/closure, and post-closure phases of the Project.

Plan modifications may also be periodically required to address mining or mineral processing changes, regulatory changes, changes in external stakeholder considerations, or as may be necessary to resolve issues arising from regular ESHS risk reviews as discussed in Sections 3.2 and 3.3 of the Project ESMS plan (see **Appendix 7B** of this ESIA). All of these changes and modifications will be controlled within the context of the ESMS plan, as described in Section 1.3.

7.2.3 Standard Operating Procedures

SOPs are the third tier of documentation noted in the ESMS model presented in **Figure 7.2-1**. The *ESMS Plan* and the various management plans will also be supported by a suite of SOPs. SOPs are written specifically to guide GGI workers and (when invoked by contract, all or in part) contractor personnel in the day-to-day performance of specific field or office activities required by upper-tier ESMS plans. SOPs will be developed with a level of detail commensurate with the phase of the project, the complexity of the task, current staffing levels, and the capabilities and experience of the workforce. SOPs may support one or several management plans and one or several Project phases. A list of the SOPs currently developed to support this ESMS Plan is presented in **Table 7.2-3**. The full suite of SOPs is included for reference in **Appendix 7C** of this updated ESIA.

Table 7.2-3: Aurora Project SOPs

<i>SOP Designator</i>	<i>SOP Title</i>
GG-01	"Solid Waste Management"
GG-02	"Preparation, Review, Approval, and Update of Standard Operating Procedures"
GG-03	"Field Inspections"
GG-04	"Identification of Non-conformances and Corrective/Preventive Action"
GG-05	"Records Management"
GG-06	"ESMS Training Program"
GG-07	"Distribution and Control of ESMS Documents"
GG-08	"Environmental and Social Footprint Surveys"
GG-09	"Identification of Project-related Safety Hazards and Assessment of Risks"
GG-10	"Prevention and Monitoring of Communicable Diseases"
GG-11	"Personal Protective Equipment"
GG-12	"First Aid and Emergency Medical Response"
GG-13	"Transportation Safety – Light Vehicles"
GG-14	"Handling and Storage of Hazardous Materials"
GG-15	"Forklift Safety"
GG-16	"Safe Operation of Heavy Equipment"
GG-17	"Vehicle Fuelling and Spill Prevention"
GG-18	"Machine Guards and Safety Barriers"
GG-19	"Welding and Cutting Safety"
GG-20	"Electrical Safety"

<i>SOP Designator</i>	<i>SOP Title</i>
GG-21	“Confined Space Work Safety”
GG-22	“Fire Prevention Program”
GG-23	“Operational Safety Meetings”
GG-24	“Recognition and Reporting of Safety Hazards”
GG-25	“Chance Archaeological Finds”
GG-26	“Safe Use of All-Terrain Vehicles”
GG-27	“Chainsaw Safety”
GG-28	“Heat Stress”
GG-29	“Determination of Environmental and Social Aspects and Significant Impacts”
GG-30	“Environmental and Social Objectives, Targets, and Performance Improvement Program”
GG-31	“Development and Maintenance of Legal and Regulatory Requirements Register”
GG-32	“Regulatory Compliance Verification Audits”
GG-33	“Internal ESMS Audits”
GG-34	“Management Reviews”
GG-35	“Community Health and Safety Awareness Meetings”
GG-36	“Lockout/Tag-out Requirements”
GG-37	“Control of Erosion and Sedimentation”
GG-38	“Working from Heights”
GG-39	“Monitoring and Maintenance of Potable Water Quality”
GG-40	“Site Security”
GG-41	“Management of Aviation Fuel and Fuelling Operations”
GG-42	“Helicopter Safety”
GG-43	“Safe Operation of Grove Model 530 Hydraulic Cranes”
GG-44	“Management of Land Clearances”

Additional SOPs required for the long-term implementation of the ESMS Plan and its supporting management plans may also be developed and issued at any time, in accordance with the change management processes outlined in Section 1.3 of the *ESMS Plan* (see Appendix 7A).

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Section 8:
Labor and Working Conditions
(Ref: IFC PS 2)

Contents

	Page
8 Labor and Working Conditions (Ref: IFC PS 2)	8-2
8.1 Summary of PS 2 Requirements	8-2
8.2 Working Conditions and Management of Workforce Relationships	8-2
8.2.1 Human Resources Policies and Procedures	8-2
8.2.2 Working Conditions and Terms of Employment	8-3
8.2.3 Workers' Organizations	8-4
8.2.4 Non-Discrimination and Equal Opportunity	8-4
8.2.5 Retrenchment	8-4
8.2.6 Grievance Mechanism	8-5
8.3 Workforce Protection	8-5
8.4 Occupational Health and Safety	8-5
8.5 Workers Engaged by Third Parties	8-9
8.6 Supply Chain Considerations	8-10

List of Tables

Table 8.4-1:	OHS SOPs

8 Labor and Working Conditions (Ref: IFC PS 2)

8.1 Summary of PS 2 Requirements

The requirements of PS 2 [see (IFC, 2012)] are guided in part by a number of international conventions and instruments developed by the International Labor Organization (ILO) and the United Nations (UN). The specific objectives of this PS are:

- to promote the fair treatment, non-discrimination and equal opportunity of workers;
- to establish, maintain and improve the worker-management relationship;
- to promote compliance with national labour and employment laws;
- to protect the workforce, including vulnerable groups such as children or migrant workers, workers engaged by third parties, and workers in the project proponent's supply chain;
- to promote safe and healthy working conditions and workforce health and well-being; and
- to prohibit any use of forced labor.

8.2 Working Conditions and Management of Workforce Relationships

8.2.1 Human Resources Policies and Procedures

Guyana Goldfields, Inc. (GGI) has established the *Guyana Goldfields, Inc. Human Resource Policy* and *Environmental, Health, and Safety Policy Statement – Aurora Projects*. These policy documents are managed as elements of the Aurora Gold Project (Project) Environmental and Social Management System (ESMS) and are appended to the Project *ESMS Plan* (see **Appendix 7A**). As noted therein, these documents contain a specific commitment to comply with all applicable laws and regulations and to comply with PS 2 requirements in particular. Periodic, systematic verification of Project performance with these compliance commitments is also a key element of the ESMS, as noted in Sections 3.1 and 7.2.2 of the Project *ESMS Plan*.

Both policy documents underscore a fundamental commitment on GGI's part to protecting the health, safety, and wellbeing of the Project workforce. A commitment to mutual respect and open communication is also emphasized and is reflected in the expectations for workforce behavior and communication outlined in the GGI "Labour Grievance Procedure." The latter has been separately reviewed and approved by the International Finance Corporation (IFC) and is also appended to the Project *ESMS Plan*.

Other administrative policies and procedures have been established [and are separately maintained by GGI's Human Relations (HR) department] and include:

- *Policy: Group Life And Accident Plans*, which provide compensatory benefits to employees/contractors in event of accident, and a named beneficiary in the event of accidental or natural death;
- *Policy: Sick Leave – Referral*, which provides for additional medical assessment (and potentially, medical management) services after ill employees have been examined, but an inconclusive diagnosis has been made by the onsite/location medical representative, requiring referral to a hospital of the employees choice; for the protection of the

employee and their coworkers, the Policy requires “fitness for work” certification by the attending physician 24 hours before the employee is permitted to return to work;

- *Policy: Sick Leave*, which provides guidance to employees who must be absent from work due to non-job-related injury or illness and reserves rights for GGI to request submittal of a medical report prior to an employee returning to work;
- *Policy: Recruitment and Placement of Employees*, which defines the process for the screening of potential job applicants and referral of screened applicants to appropriate GGI management staff for final selection decisions;
- *Policy: Termination*, which defines specific procedures applicable to voluntary and involuntary terminations and the appropriate distribution of termination benefits; and
- *Policy: Annual Leave*, which presents the requirements of the accrual of leave or vacation benefits, as well as methods for requesting additional unpaid leave beyond that which has already accrued.

GGI has also developed a Project-specific *Occupational Health and Safety/Accident Prevention Plan* and a comprehensive suite of standard operating procedures (SOPs) focused on the management of specific occupational health and safety issues (OHS) that may be encountered over the life of the mine. These are discussed further in Section 8.4 below.

It should also be noted that by inclusion of the aforementioned policies and procedures in the *ESMS Plan*, they are subject to periodic audits designed to evaluate their effectiveness in actual practice, over the life of the mine; see Section 7 of this updated ESIA as well as *ESMS Plan* Sections 7.22 and 7.4 (**Appendix 7A**).

8.2.2 Working Conditions and Terms of Employment

As previously noted, the GGI *Human Resources Policy* (appended to the *ESMS Plan*; see **Appendix 7A**) contains a specific commitment to comply with all applicable laws and regulations and to comply with PS 2 requirements in particular. It also demonstrates GGI’s commitment to the establishment of working conditions that protect the health, safety, and wellbeing of the Project workforce. Particular attention has been paid to workforce accommodations via the design and construction of a modern, modular man-camp at the Aurora site (see **Figure 2.2-4** for an early works construction photograph). The man-camp will contain: well-ventilated modular housing units with private and semiprivate bathrooms; laundry services; full canteen services with refrigerated food storage and sanitary food preparation, serving, and dining areas; a variety of recreational and entertainment equipment and facilities; limited internet access; a potable water treatment plant; a sanitary waste water treatment plant; and a licensed solid waste landfill. At the Buckhall logistics support area, modern administrative offices, canteen facilities, accommodations, and supporting infrastructure have also been provided for GGI employees based at Buckhall as well as other GGI employees, truck drivers, and other site visitors who must stay overnight pending departure of the next convoy to the Aurora site. See **Figure 2.2-2** for a photograph of a building representative of the new construction at Buckhall; a full site layout drawing is also provided (see DWG-C0103 in **Appendix 2A**).

PS 2 requirements for treatment of migrant workers are not considered to be applicable to the Project as the work is not seasonal in nature, nor does it require the support of an itinerant workforce. It should be noted that GGI's Environmental Permit (Guyana EPA, 2010) specifically requires that GGI endeavor to restrict influx to the Project area. All potential applicants will be advised that hiring activities are conducted only through GGI's Georgetown offices and that all applications are subject to the same hiring conditions, regardless of the applicant's home location or country of origin.

8.2.3 Workers' Organizations

The *GGI Human Resources Policy* (appended to the *ESMS Plan*; see **Appendix 7A**) specifically permits workers to form and join organizations of their own choosing and to bargain collectively, without any interference or consequences with respect to their continuing employment.

8.2.4 Non-Discrimination and Equal Opportunity

The *GGI Human Resources Policy* (appended to the *ESMS Plan*; see **Appendix 7A**) specifically prohibits discrimination in hiring practices. The policy also prohibits sexual harassment or intimidation in any form; this is also specifically identified as improper conduct in the Project's approved "Labour Grievance Procedure" (also appended to the *ESMS Plan*; see **Appendix 7A**) and constitutes potential grounds for dismissal.

8.2.5 Retrenchment

The *GGI Human Resources Policy* (appended to the *ESMS Plan*; see **Appendix 7A**) requires the development of a plan to mitigate the effects of retrenchment (i.e., the significant general layoff that will predictably occur at the end of mine life, or that could occur in response to a temporary shutdown or other major disruption of Project operations). In addition, Guyanese law¹ requires severance or redundancy payments to be paid when employees are terminated in general layoff scenarios such as those just described. Because GGI employees will be made redundant in such circumstances, they are entitled to an appropriate severance package. The minimum severance payments are:

- one week's wages per year for the first five years worked;
- two weeks wages for each of the second five years worked; and
- three weeks wages for each year after the tenth year worked, up to a maximum of 52 weeks.

This means that any workers employed for more than 23 years will be entitled to a full year's salary upon retrenchment. Good international industry practice (GIIP) is to ensure that any outstanding payments (including payments for unused leave, wages or salary in arrears, and pension benefits) are received by the employee on their last day of work. The funding necessary to provide these benefits is recognized as an element of the Project's *Mine*

¹ See "Termination of Employment and Severance Pay Act 1997 (ACT No. 19 of 1997)"; (Republic of Guyana, 1997)

Reclamation and Closure Plan (see **Appendix 7B**) and has been included in the initial decommissioning and closure cost estimate provided therein.

As noted in Section 5.3.9 of the *Mine Reclamation and Closure Plan*, in addition to the severance payments required by Guyanese law, GGI will assist retrenched workers in several other ways:

- If at all possible, GGI will try to re-employ retrenched workers in other jobs for which they are qualified.
- If employees are not retained and moved to another project, GGI may choose to mitigate the adverse effects of retrenchment by offering vocational, entrepreneurial, or skills training to improve employees' prospects in the local and regional job market. This requires not only an understanding of the job market workers face and the skills they possess, but also an understanding of the types of training and assistance that the workers themselves prefer. It is expected that this information will be obtained through the stakeholder consultation processes documented in the *Project Community Relations Management Plan* (see **Appendix 7B**).
- If a severance is paid, GGI will also provide access to financial counselling to help workers plan how best to spend or invest the payment.

8.2.6 Grievance Mechanism

As previously noted, the *ESMS Plan* (see **Appendix 7A**) contains a "Labour Grievance Procedure" that has been separately reviewed and approved by IFC. Along with a companion "Community and Environmental Grievance Procedure" (also appended to the *ESMS Plan*), this procedure was initially implemented in the early works construction phase of the Project. It is understood that training in grievance procedure requirements has been provided to all staff, and hard copies are prominently posted at the Buckhall logistics support facility and the current Aurora site man-camp.

8.3 Workforce Protection

The *GGI Human Resources Policy* (appended to the *ESMS Plan*; see **Appendix 7A**) specifically prohibits all forced or child labor. A minimum hiring age of 18 has also been established, since Guyanese labor law prohibits employment of persons under 18 for any job which potentially "jeopardizes health and safety" or requires work at night (ILO, 2011).

8.4 Occupational Health and Safety

The *GGI Environmental, Health, and Safety Policy Statement – Aurora Project* (appended to the *ESMS Plan*; see **Appendix 7A**) emphasizes a fundamental commitment to:

- the establishment of a safe working environment;
- the establishment and achievement of specific OHS goals and objectives;

- periodic review of the OHS elements of the Project's ESMS for their continued suitability and effectiveness, and for taking appropriate corrective and preventive action where any deficiencies or weakness in practice are observed;
- compliance with all applicable OHS laws and regulations; and
- appropriate communication of policy requirements with the GGI workforce, consultants, contractors, and external stakeholders.

GGI has addressed management of its OHS needs as an integral component of the Project ESMS, which, as noted in ESMS Plan Table 1-1, is designed to address the OHSAS 18001² OHS management system standard, as well as the ISO 14001 environmental management system standard³ and PS 1 (IFC, 2012) requirements. Section 7 and **Appendix 7A**). Sections 3.3, 4.1, 4.3.2, 6, and 7.2.3 of the *ESMS Plan* specifically address key OHS management issues. As noted in ESMS Plan Section 1.2, the initial iteration of a Project-specific *Occupational Health and Safety/Accident Prevention Plan* has also been prepared (see **Appendix 7B** for full text). This version of the plan addresses all aspects of OHS as the Project enters the major construction phase, with emphasis on identifying required safe behaviors, preventive/protective measures, and the routine implementation of SOPs to minimize the potential for accidents, injuries, and illness within the GGI and contractor workforce. The *Occupational Health and Safety/Accident Prevention Plan* is supported by an initial suite of SOPs (see **Table 8.4-1**) focused on the management of specific OHS issues that may be encountered over the life of the mine.

² OHSAS 18001:2007, *Occupational health and safety management systems – Specification*; OHSAS Project Group Secretariat, London, United Kingdom 2007. OHSAS 18001 is selected as a GIIP for OHS program management, as well as for its structural and contextual compatibility with PS-1 and ISO 14001. References to this standard should not be construed as a commitment to undertake third-party certification.

³ ISO 14001:2004, *Environmental management systems – Requirements with Guidance for Use*; International Organization for Standardization, Geneva, Switzerland, 2004. ISO 14001 is considered as a GIIP only. References to this standard should not be construed as a commitment to undertake third-party certification.

Table 8.4-1: OHS SOPs

SOP No.	SOP Title (OHS Topics)
GG-01	“Solid Waste Management”
GG-02	“Preparation, Review, Approval, and Update of Standard Operating Procedures”
GG-03	“Field Inspections”
GG-04	“Identification of Non-conformances and Corrective/Preventive Action”
GG-05	“Records Management”
GG-06	“ESMS Training Program”
GG-09	“Identification of Project-related Safety Hazards and Assessment of Risks”
GG-10	“Prevention and Monitoring of Communicable Diseases”
GG-11	“Personal Protective Equipment”
GG-12	“First Aid and Emergency Medical Response”
GG-13	“Transportation Safety – Light Vehicles”
GG-14	“Handling and Storage of Hazardous Materials”
GG-15	“Forklift Safety”
GG-16	“Safe Operation of Heavy Equipment”
GG-17	“Vehicle Fuelling and Spill Prevention”
GG-18	“Machine Guards and Safety Barriers”
GG-19	“Welding and Cutting Safety”
GG-20	“Electrical Safety”
GG-21	“Confined Space Work Safety”
GG-22	“Fire Prevention Program”

SOP No.	SOP Title (OHS Topics)
GG-23	"Operational Safety Meetings"
GG-24	"Recognition and Reporting of Safety Hazards"
GG-26	"Safe Use of All-Terrain Vehicles"
GG-27	"Chainsaw Safety"
GG-28	"Heat Stress"
GG-29	"Determination of Environmental and Social Aspects and Significant Impacts"
GG-30	"Environmental and Social Objectives, Targets, and Performance Improvement Program"
GG-31	"Development and Maintenance of Legal and Regulatory Requirements Register"
GG-32	"Regulatory Compliance Verification Audits"
GG-35	"Community Health and Safety Awareness Meetings"
GG-36	"Lockout/Tag-out Requirements"
GG-38	"Working from Heights"
GG-39	"Monitoring and Maintenance of Potable Water Quality"
GG-40	"Site Security"
GG-41	"Management of Aviation Fuel and Fuelling Operations"
GG-42	"Helicopter Safety"

The full text of the SOPs listed in **Table 8.4-1** (and several other SOPs with ESMS support functions) is provided in **Appendix 7C** of this updated ESIA. Additional OHS-related SOPs may be expected to be developed as the Project enters the operational phase (and underground operations in particular), as discussed in Sections 1.2 and 1.3 of the Project *ESMS Plan*.

Apart from the *Occupational Health and Safety/Accident Prevention Plan*, GGI has also developed a range of other mitigation/management plans that have significant OHS program support elements. These are listed as follows:

- *Construction Management Plan – Early Works;*
- *Emergency Preparedness and Response Plan;*
- *Hazardous Materials Management Plan;*
- *Spill Prevention, Control, and Contingency Plan;*
- *Buckhall Spill Contingency Plan;*
- *Transportation Management Plan;*
- *Waste Management Plan;*
- *Influx Management Plan;* and
- *ESHS Monitoring Plan.*

Full text versions of these construction-phase plans are provided for reference in **Appendix 7B**. GGI expects to update the aforementioned plans, where required, as well as develop and issue several additional management plans prior to the operations phase of the Project. These additional plans will also have important OHS functions or considerations, and include:

- *Construction Management Plan – Major Construction;*
- *Blasting Management Plan;*
- *Overburden Management Plan;*
- *Annual Mining Plan;*
- *Mill/Leach Plant Operations Plan;*
- *Tailings Area Management Plan;*
- *Cyanide Management Plan;*
- *Waste Management Plan;*
- *Air Quality Management Plan;* and
- *Noise & Vibration Management Plan.*

Brief descriptions of the function of all of these plans are provided in Section 1.1 of the *ESMS Plan*.

SOP and management plan implementation will be subjected to periodic audits designed to evaluate effectiveness in actual practice, as noted in *ESMS Plan* Sections 7.2.2 and 7.4 (**Appendix 7A**). SOPs or management plans may be modified, or additional ESMS documents developed under consistent change control protocols, as necessary in response to changing project needs as discussed in Sections 1.2 and 1.3 of the Project *ESMS Plan*.

8.5 Workers Engaged by Third Parties

As of the submittal date of this updated ESIA, GGI does not anticipate any engagement of workers through third parties. Should requirements for contract employment services appear

over the course of the project, the requirements of *ESMS Plan* Section 4.3.3, “Control of Contractor Operations” (see **Appendix 7A**) will apply to the third party employment contractor, in the same manner as this Section of the *ESMS Plan* would apply to any other Project supplier or contractor. At a minimum, purchase orders (POs) or contracts for these services would invoke GGI’s “Labour Grievance Procedure” (appended to the *ESMS Plan*; see **Appendix 7A**) as well as other selected *ESMS Plan* or other ESMS policy, management plan, and/or or SOP requirements, as appropriate for the proposed scope of work.

8.6 Supply Chain Considerations

GGI’s *Human Resources Policy* specifically prohibits forced or child labor, and it is understood that these conditions and a minimum hiring age of 18 are extended to all contractors. Detection of any forced or child labor issues on the part of any GGI supplier or contractor is considered grounds for contract termination.

The requirements of *ESMS Plan* Section 4.3.3, “Control of Contractor Operations” (see **Appendix 7A**) also apply to all suppliers and contractors. Where the contractor supplies or transports cyanide reagent to the Project, governing contracts or POs will specifically invoke requirements for establishing and maintaining continued certification to the ICMC. In all other cases, where significant OHS issues are associated with the work to be performed or materials or equipment to be delivered, the contractor’s OHS program capabilities will be evaluated as a contract condition. If found deficient, GGI may elect to invoke specific ESMS management plan and/or OHS procedure requirements, elements thereof, or other specific requirements as appropriate for the nature of the hazard and the proposed scope of work.

References

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- IFC, 2012. IFC Performance Standards on Environmental and Social Sustainability. International Finance Corporation, Washington, D.C. January 1, 2012.
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Section 9:
Resource Efficiency and
Pollution Prevention
(Ref: IFC PS 3)

Contents

	Page
9 Resource Efficiency and Pollution Prevention (Ref: IFC PS 3)	9-3
9.1 Summary of PS 3 Requirements	9-3
9.2 General Resource Efficiency Considerations	9-3
9.2.1 Power Generation, Fuel Use, and Minimization of GHG Emissions	9-4
9.2.2 Use of Water Resources	9-6
9.3 Pollution Prevention	9-9
9.3.1 Air Quality Management Strategy	9-9
9.3.2 Water Quality Management	9-10
9.3.3 Land Impact Management Strategy	9-33
9.4 Management of Pesticides	9-38

List of Figures

- Figure 9.2-1: TMA and MWP Discharge and Monitoring Points
- Figure 9.3-1: TMA Groundwater Infiltration Model: Plan View of Major Project Features
- Figure 9.3-2: Comparison of Horizontal Extent of Fe Concentrations (mg/L) in Groundwater beneath TMA, Year 2 and Year 18
- Figure 9.3-3: Location of Sectional Model Views, Vertical Extent of Fe Concentrations (mg/L) in Groundwater at TMA
- Figure 9.3-4: Comparison of Vertical Extent of Fe Concentrations (mg/L) in Groundwater beneath TMA, Year 2 and Year 18
- Figure 9.3-5: Predicated Discharge Concentrations (mg/L) of TMA Effluent Constituents at Spillway, Operations and Closure/Post-closure Phases
- Figure 9.3-6: CN_F Distribution in TMA Diversion Pond 2 in Years 1, 2, 13, and 22
- Figure 9.3-7: TSS Distribution in TMA Diversion Pond 2 in Years 1, 2, 13, and 22
- Figure 9.3-8: Predicated Discharge Concentrations (mg/L) of MWP Effluent Constituents at Spillway, Operations and Closure/Post-closure Phases
- Figure 9.3-9: As Distribution at MWP Spillway in Years 1, 2, 13, and 22
- Figure 9.3-10: TSS Distribution at MWP Spillway in Years 1, 2, 13, and 22
- Figure 9.3-11: Comparison of Horizontal Extent of As Concentrations (mg/L) in Groundwater beneath MWP, Year 2 and Year 18
- Figure 9.3-12: Location of Sectional Model Views, Vertical Extent of As Concentrations (mg/L) in Groundwater beneath MWP
- Figure 9.3-13: Comparison of Vertical Extent of As Concentrations (mg/L) in Groundwater beneath MWP, Year 2 and Year 18
- Figure 9.3-14: Typical Stainless Steel ISO Delivery/Mixing Container

List of Appendices

Appendix 9A	Geochemical Testing Reports (KCB)
Appendix 9B	Hydrogeology/Groundwater Inflow Study (ITASCA)
Appendix 9C	Water Quality Study Report (ENVIRON)
Appendix 9D	Report from Independent Review of TMA Design

9 Resource Efficiency and Pollution Prevention (Ref: IFC PS 3)

9.1 Summary of PS 3 Requirements

International Finance Corporation (IFC) Performance Standard 3 (PS 3; IFC, 2012) recognizes that increased economic activity and trends toward urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. There is also a growing global consensus that the current and projected atmospheric concentration of greenhouse gases (GHG) threatens the public health and welfare of current and future generations. At the same time, more efficient and effective resource use and pollution prevention and GHG emission avoidance and mitigation technologies and practices have become more accessible and achievable in virtually all parts of the world. Pollution prevention and GHG emission avoidance and mitigation technologies are often implemented through methodologies for undertaking continuous improvement of environmental performance [e.g., ISO 14001 (International Organization for Standardization, 2004)]. These methodologies are similar in many important respects to other methodologies used to enhance quality or productivity, and are well known and widely implemented in the mining industry and other sectors.

The stated objectives of PS 3 are to:

- promote more sustainable use of resources, including energy and water;
- avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities; and
- reduce project-related GHG emissions.

9.2 General Resource Efficiency Considerations

The Aurora Gold Project (Project) is not reflective of any general national trends towards urbanization. Quite to the contrary, the Project is being conducted in a very remote setting in which it is expected that direct impacts on people and communities will be limited over the life of the Project. It should also be noted that as a condition of its Environmental Permit (Guyana EPA, 2010), GGI is required to endeavor to minimize influx to the Project area. Commercial opportunities and the potential resource impacts associated with commercial growth will therefore be very limited and carefully controlled through the processes defined by the Project's *Influx Management Plan* and *Community Relations Management Plan*.

The Project will out of necessity consume certain types of resources (e.g., energy, fuel, water, lubricants, tires, steel, other consumables) on an ongoing basis over the life of the mine. However, the Project's consumption of resources is subject to the general economic constraints of a changeable commodity market, as well as:

- an advanced set of environmental and social policy commitments with a sustainable development focus [see the policy statements appended to the Project *Environmental and Social Management System Plan (ESMS Plan)* included as **Appendix 7A** of this updated Environmental and Social Impact Assessment (ESIA);
- commitments to comply with the IFC PSs (IFC, 2012); environmental, health, and safety (EHS) guidelines (IFC, 2007); and other good international industrial practices (GIIPs);
- commitments to comply with the International Cyanide Management Code (ICMC), which includes specific requirements for establishing appropriate process controls to minimize the consumption of sodium cyanide reagent; and
- the requirements of a Project-specific environmental and social management system (ESMS; see Section 7 and **Appendices 7A, 7B, and 7C**) based specifically on the type of continuous improvement methodologies referred to in PS 3 and noted in Section 9.1.

Collectively, these factors may be expected to prompt GGI to continually seek operational efficiencies and increased cost-effectiveness in its mining operations. Over time, GGI's responses to these drivers are expected to be reflected in the overall minimization of resource use and increased effectiveness of specific pollution prevention and mitigation measures. Minimization and efficiency strategies generally applicable to the use of key Project resources are summarized in the following paragraphs.

9.2.1 Power Generation, Fuel Use, and Minimization of GHG Emissions

Current strategies for power generation, maximizing efficiencies in fuel use, and minimization of GHG emissions are presented as follows.

9.2.1.1 Power Generation

As a result of the alternatives evaluations discussed in Section 3, the current Project design presented in (TetraTech, 2013) calls for onsite electrical power generation at the Aurora site using a series of 3.5 megawatt (MW) generators fired by No 4 fuel oil (a blend of diesel and No. 6 heavy fuel oil). No. 4 fuel oil was selected as a reasonable compromise between high-cost diesel fuel and No. 6 heavy fuel oil (HFO). HFO had been recommended by a previous feasibility study [see (SRK, 2012)], but does not have as desirable an air emissions profile and is considerably more difficult to transport and handle than the No. 4 blend. Electrical power needs at the Buckhall logistics support facility are much more limited and will be provided by one or more appropriately-sized diesel generator sets.

At the Aurora site, electrical power will initially be supplied by three 3.5 MW generators; see **Appendix 2A**, DWG-E0102. As the Project moves towards underground operations, generation capacity will be expanded in the first of a series of 3.5 MW increments in order to meet the demands of mine dewatering, ore conveyance, crushing, milling, and mineral processing, maintenance shop and man-camp operations, and other elements of Project infrastructure. Maximum installed generation capacity at peak underground operation is expected to be 28 MW.

Power demands in electrical equipment will be minimized (to the extent possible without compromising safe and reliable operations) by the specification of high-efficiency motors, pumps, lighting systems, ventilation systems, refrigeration and cooling systems, and other electrically operated equipment in the development of the final design of the Project.

Power generation costs are expected to remain a critical component of Project economics over the entire mine life cycle. Therefore, as an element of the continual improvement processes established by the Project's ESMS [see Sections 3.2 and 4.1 of the *ESMS Plan (Appendix 7A)*], GGI will continue to systematically seek alternatives that reduce overall amount and costs of power generation and the level of fuel consumption, while maintaining or minimizing the associated environmental footprint and any associated environmental and social impacts.

9.2.1.2 Fuel Use

The Project will employ two major fuel types: No. 4 fuel oil, for electrical power generation at the Aurora site, as discussed in 9.2.1.1, and No. 2 diesel, for all major motorized mobile and stationary equipment. The latter is expected to include haul trucks, drill rigs, loaders, excavators, graders, and bulldozers, as well as light mine trucks and crew buses. Diesel fuel is preferred over gasoline for its superior economy and generally safer handling and storage characteristics. Minor quantities of other special purpose fuels [e.g., liquefied petroleum gas (LPG)], propane, chainsaw fuel, emergency supplies of aviation fuel] may also be stored on site. These are generally associated with limited or special purpose uses for which potential economic and environmental benefits are overridden by technical necessities and limited usage rates. Limitation of fuel types also reduces infrastructure, the associated environmental footprint, and corresponding and occupational health and safety program demands.

9.2.1.3 Management of GHG Emissions

As part of the development of the final design for the project, GGI and its engineering/procurement/construction (EPC) contractor will assess the GHG emissions potential for heavy vehicles, generator sets, and other major items of motorized equipment, and to the extent practicable (e.g., the selection of No. 4 fuel instead of No. 6 HFO for electrical power generation as discussed in Section 9.2.1.1) will select equipment with the lowest overall GHG emissions signature. The current Project design minimizes forest clearance, and the *Environmental and Social Management System Plan (ESMS Plan)* and associated management plans; see **Appendix 7A**) also require that clearance of forest area be minimized to the extent possible, with cleared areas and the exposed faces of earthworks revegetated as soon as possible as part of ongoing erosion control activities. However, as inundated forest/rotting vegetation may be a potentially significant source of CO₂ emissions over time, the designs for the Tailings Management Areas (TMA), Mine Water Pond (MWP), Fresh Water Pond (FWP), and other emergency or settling ponds will typically require construction in basins at least partially cleared of vegetation, which, along with topsoil will be reserved for reclamation of waste rock stockpiles and other areas of ground surface disturbed as part of Project activities.

Based on the final design data developed by the EPC contractor, initial GHG emissions calculations will be made to determine a predicted annual CO₂-equivalent emissions value for the major components of the Project that are within GGI's control [i.e., the Aurora site, the Aurora (M3) road extension, the Tapir Crossing ferry, the Buckhall logistics support facility, and

the Project's vehicle fleet]. The projected emissions associated with transportation of materials, equipment, and personnel between the Aurora site and Buckhall will also be considered. If the projected CO₂-equivalent emissions are estimated to be $\geq 25,000$ tonnes annually (the reporting threshold established by PS 3), such emissions will be considered to represent a significant environmental impact, and as such will be subject to the performance improvement protocols established by Sections 3.1, 4.1, and 4.2 of the Project's *Environmental and Social Management system Plan (ESMS Plan; see Appendix 7A)*. At a minimum, if the 25,000 tonne threshold is estimated to be exceeded, an annual GHG quantification and reporting program will be developed and incorporated in the Project's *Air Quality Monitoring Plan* (see Section 7.2.2). GHG estimation methodologies will be based on guidance provided by the Intergovernmental Panel on Climate Change (IPCC) or other recognized GIIPs. GGI will also monitor periodic updates to the Republic of Guyana's low-carbon development strategy for its potential relevance to any proposed GHG quantification and reporting program; see (Republic of Guyana - Office of the President, 2013).

9.2.2 Use of Water Resources

As noted in Section 4.3, the Project is located in a tropical setting with high (i.e., > 2 meters) annual rainfall, and is expected to have minimal consumptive impacts on regional or local water resources. The hydrologic baseline of the Project is presented in Section 4.5 of this updated ESIA. The Project's projected interaction with regional hydrogeology and hydrology was further examined by the following studies:

- an investigation leading to the optimization of the of open pit geometries and the underground mining methods to be used, as documented in Section 16.1 of (TetraTech, 2013) and **Appendix 9B**, "Predictions of Groundwater Infiltration to Sublevel Retreat Mining at Guyana Goldfields' Aurora Mine, Guyana, South America" (ITASCA Denver, 2013); and
- a water quality modeling study that independently examined the projected effectiveness of major water management features; see "Water Quality Modeling for Evaluation of Surface Water and Groundwater Impacts of Aurora Gold Mining Project, Guyana" (ENVIRON, 2013), the full text of which is included as **Appendix 9C**.

The numerical models generated in these two studies covered an area extending from the Cuyuni River to the southern edge of the TMA. All models used soil test results and pumping tests conducted by AMEC between 2009 and 2011, and by SRK in 2012. Most of these tests were conducted adjacent to the proposed open pit area; six boreholes were located near the southern boundary of the proposed TMA. As noted in **Appendix 9B**, no borings were available in the northern or central part of the TMA. Horizontal (versus distance) and vertical (versus depth) hydraulic conductivities were therefore estimated based on available soil test data. Two patterns were observed:

- for unconsolidated deposits, no trends or changes in hydraulic conductivity were observed in relation to the distance from the Cuyuni River; and,

- for weathered bedrock, hydraulic conductivity consistently decreased as distance from the Cuyuni River increased.

9.2.2.1 Industrial Water Use

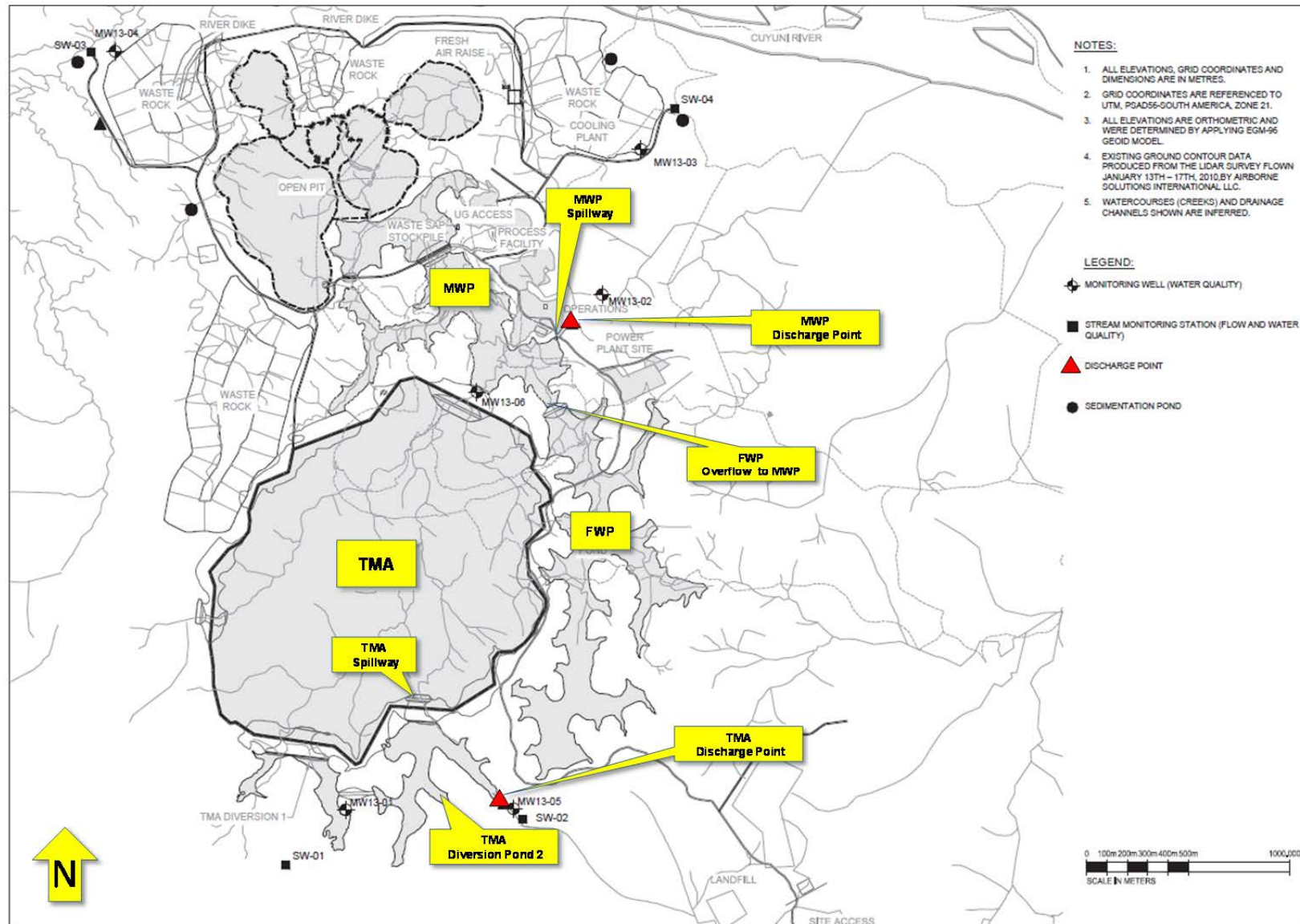
The Project area receives upwards of 2 meters of rainfall annually, which means that sufficient industrial (non-potable) water is available through collection of precipitation and recycling sources without having to abstract water from the Cuyuni River or its tributaries, or having to extract significant volumes of groundwater via supply wells. Industrial water for the Project will be supplied primarily by water reclaimed from TMA supernatant via barge-mounted pumps and a return pipeline. Depending on seasonal conditions, the latter water source may also include a significant amount of runoff and precipitation inflow. Process plant startup water and additional industrial makeup water will be provided by the FWP, which will be constructed due east of the TMA, approximately 1 km south of the processing plant as shown in **Figure 9.2-1**. The FWP will be fed primarily by precipitation runoff and any seeps and/or springs naturally occurring within the FWP basin. Any FWP overflow will be directed to the MWP and will provide an additional dilution source for MWP water as discussed in Section 9.3. Raw industrial water needs will be also be minimized further by the recycling of pre-leach thickener overflow water (see **Figure 2.4-3**).

Industrial water use is related primarily to the milling of ore (e.g., gland seal water for the ball mills), and the mixing of reagent/process solution, with other additional significant usage associated with facility and equipment washdown and firefighting systems, and the suppression of dust on Project roadways in dry seasonal conditions.

9.2.2.2 Potable Water Use

Potable water resources will be derived in large part from rooftop and/or engineered rain water harvesting/catchment collection systems, potentially supplemented, in dry seasonal conditions, by additional water drawn from deep supply wells drilled into the underlying bedrock (TetraTech, 2013). Rainwater harvesting has a long tradition in Guyana, and is an ideal strategy for the site due to the substantial levels of precipitation received. As previously noted, there will be no direct abstraction of water from the Cuyuni River or its tributaries for potable or any other use. Raw water for potable use will be collected in a series of lined reservoirs and storage tanks and treated in appropriately sized modular water treatment plants that will be installed at the Aurora man-camp, the administrative office facilities near the mill and process plant, and at the Buckhall logistics support facility.

Figure 9.2-1: TMA and MWP Discharge and Monitoring Points (Source: Appendix 2A, TetraTech DWG-N0100 Rev A)



9.2.2.3 Water Management Feature Configurations at Closure

As noted in (TetraTech 2013) and **Appendix 9B**, precipitation runoff and groundwater inflows are such that the underground mine and open pit areas are expected to fill after mining ceases and dewatering (i.e., collection of accumulated runoff/inflow and pumping to the MWP) is discontinued. At the final elevation represented in **Figure 9.2-1**, the pit lakes will be interconnected and will drain freely to the Cuyuni River through a small, permanent and appropriately stabilized exit channel. When post-closure monitoring indicates that all necessary water quality parameters are being consistently met (see Section 9.3.2) a small residual pond will be created in the southeast corner of the reclaimed TMA, draining to TMA Diversion Pond 2 and thence to the environment. The embankment between the FWP and MWP will be breached, and the interconnected system permitted to drain freely to the environment over the MWP spillway. Given that the Cuyuni River is approximately 750 km long and drains a basin area of approximately 53,500 km² (AMEC 2009), the rerouting of natural drainage through the pit lakes (and the closed configurations of the TMA and interconnected diversion ponds and the interconnected FWP and MWP) is expected to have no detectable influence on river flow.

9.3 Pollution Prevention

This section addresses Project strategy for the prevention or minimization of the potential for pollutants to be released to the air, water, or land from routine, non-routine, or accidental circumstances. The prevention of pollution is integral to the continual improvement processes established by the Project's ESMS [see Sections 3.2 and 4.1 of the *ESMS Plan* (**Appendix 7A**)]. GGI will continue to systematically seek improvements and alternatives that prevent or minimize pollution, while maintaining or minimizing the overall environmental footprint of the Project and any associated environmental and social impacts.

9.3.1 Air Quality Management Strategy

Overall Project air quality impacts are expected to be minor, as discussed in Section 6; however, GGI will adopt strategies as part of the *Project Air Quality Management Plan* (see Section 7.2.2) and *ESMS Plan* (see **Appendix 7A**) to minimize such impacts, to the extent practicable and economically viable. Potential air quality impacts to adjacent communities from the use of convoys to the and from the Aurora site are expected to be only of potential concern at Buckhall, due to the proximity of the local community. Such impacts will typically be mitigated by limiting the size of individual convoys, by requiring transportation contractors to maintain their equipment in serviceable condition (i.e., no thick or dark emissions), and, in dry or dusty seasonal conditions, by watering roadways near the Buckhall and Aurora sites with water or environmentally benign surfactants. Increased boat and towboat/barge traffic to and from the Buckhall wharf and fuelling trestle may be expected, especially during the construction phase of the Project. Impacts from marine air emissions sources at Buckhall will be mitigated by the establishment of appropriately spaced barge delivery schedules.

At the Aurora site, primary emissions sources will be the No. 4 fuel oil-fired generator sets, heavy vehicles and other diesel-fueled motorized equipment, and airborne dust from haul and access roads in dry seasonal conditions. The carbon-in-leach (CIL) tanks and clarifier in the process circuit will be open to the atmosphere, but under a roofed structure with open sides, and it is expected that natural ventilation and ICMC-compliant pH controls on the leaching

process will minimize the potential for any release or buildup of trace quantities of hydrogen cyanide (HCN) gas in the workspace. The *Air Quality Management Plan* will require at least annual monitoring of ambient and workspace air quality at both the Aurora and Buckhall sites, beginning in the major construction phase of the Project. Annual monitoring data will be evaluated and mitigation measures adjusted as warranted, as part of the environmental performance improvement process defined by Sections 3.2, 3.2, 4.1, and 4.2 of the Project *ESMS Plan* (see **Appendix 7A**).

9.3.2 Water Quality Management

As noted in Sections 3, 4, and 5 and many other sections of this updated ESIA, water quality in the Cuyuni River and its tributaries has been significantly degraded from the impacts of many decades of artisanal and small-scale mining (ASM), particularly from increased sediment loads from uncontrolled dredging operations, mining of alluvial deposits on tributaries, and spills or releases of petroleum hydrocarbons and other pollutants. The overriding water quality strategy for the Project is to prevent or minimize any water quality impacts that would place any additional environmental burden on a watershed and river system that has already been substantially degraded. Where historical ASM impacts are observed within the boundaries of GGI's mining license, they will be remediated (i.e., cleaned up and revegetated to minimize potential surface water quality impacts) under the provisions of the project's *Waste Management Plan* and *Erosion Prevention and Control Plan* (see **Appendix 7B**).

The Project is also located in an area in which annual rainfall averages approximately 2450 mm, expressed over two discrete rainy seasons that typically occur from mid-April to mid-August and again from mid-November to the end of January (AMEC, 2011). Developing an understanding of the site water balance was critical to the development of the current conceptual design for the mine presented in (TetraTech, 2013). As noted therein, an initial water balance model (see **Figure 2.4-2**) was therefore developed for the Project using the GoldSim™ software platform. This model simulated operational levels for the MWP, FWP, and TMA from predicted precipitation and other inflows and outflows associated with Project infrastructure. Initial water balance results were strongly positive, and the resulting preliminary designs for major elements of Project infrastructure therefore assume that excess water may accumulate in specific seasonal situations, and, for the sake of environmental, safety, and operational reasons, must be periodically discharged to the environment. Based on the conceptual design presented in (TetraTech, 2013), periodic discharges will be required for the TMA, and will be required more or less continuously from the MWP. Water discharged from the TMA spillway will be routed to TMA Diversion Ponds 1 and 2, for additional settling and dilution prior to entering the environment. Water from the MWP will be settled and further diluted by discharge from the upgradient FWP prior to discharge to the environment. Pond locations, discharge points, and an initial array of surface water and groundwater monitoring points are described in **Figure 9.2-1**. The settling and dilution effects designed into these structures, in combination with a wide range of spill prevention and containment measures and the effective detoxification of residual cyanide in the tailings from mineral separation processes, are all key components of a water quality management strategy designed to ensure that all effluents released to the environment meet the minimum water quality discharge standards established by Table 1 of "Environmental, Health, and Safety Guidelines for Mining" (IFC, 2007) and applicable standards of practice in the ICMC.

The following paragraphs summarize the conceptual water and process tailings management plans for the Project, with emphasis on those aspects that relate specially to achieve the noted effluent quality goals, and describe the results of an independent water quality modeling effort conducted at GGI's direction in order to assess the predicted effectiveness of the conceptual design presented in (TetraTech, 2013), relative to the achievement of those same effluent goals.

9.3.2.1 Project Water Management Plan

A water management approach was developed in (TetraTech, 2013) to address flood protection for the open pit and underground operations, the handling of water impacted by mining and mineral processing activities, and management of site runoff. This approach will form the technical basis of a comprehensive *Project Water Management Plan*, which will be developed and documented with the assistance of the EPC contractor, and administered as an element of the Project ESMS (see Section 7 and **Appendix 7A**). The *Water Management Plan* will reflect the final designs of all major water management structures, and will address the long-term use and periodic update of a probabilistic water balance model and monitoring program throughout the construction, operations, and closure/post-closure phases of the Project. The *Water Management Plan* will address the routine monitoring of water levels and meteorological data to ensure that required design freeboards are maintained in all retention structures. Seepage, reclaim, and effluent water quality will also be monitored to ensure that any discharges remain within the effluent guidelines established by Table 1 of (IFC, 2007) and the ICMC. Guidance on the development and implementation of any required mitigation measures will also be provided.

The underlying objectives of the *Water Management Plan* will be to:

- divert as much water as possible away from the open pit and TMA areas;
- minimize the use of fresh water and maximize reuse of process water (including TMA supernatant/reclaim water);
- reduce the sediment load in runoff from waste rock stockpiles to below (IFC, 2007) total suspended solids (TSS) limits (See Section 9.3.);
- maintain trafficable site access during storm events; and
- to maintain discharge water quality values below (IFC, 2007) Table 1/ICMC discharge limits.

The main components of the Project's water management infrastructure are shown in **Figure 9.2-1** and are discussed further as follows:

- **Cuyuni River Dikes**; saprolite earthfill river dikes (see **Figure 9.2-1** and **Appendix 2A**, DWG-C0115) are to be constructed at two locations along the Cuyuni River in order to mitigate potential flood risks to the open pit and underground operations. These will be

designed for the 10,000-year Probable Maximum Flood (PMF) and the Maximum Credible Earthquake (MCE).

- **Open Pit Diversion Channels;** to the extent possible, unimpacted site runoff will be diverted away from the open pit in appropriately vegetated channels discharging to the Cuyuni River, in a progressive or staged manner to avoid the accumulation of large flows and water volumes near the pit perimeter. Locations will be established as part of the final design effort. If diversion channels cannot be constructed due to site topography or other conditions, unimpacted runoff will be collected into simple ponds and pumped to the river.
- **FWP;** the FWP will be constructed to serve as a source of unimpacted start-up and makeup water for the mill and the mineral separation process plant; the pond will be filled from precipitation and any springs or seeps captured in an approximately 140 ha drainage basin due east of the TMA. During the operational phase of the project, the FWP will be designed to overflow into the MWP through a service spillway.
- **MWP;** the MWP is designed as a clarification and retention pond, and will receive runoff and accumulated ground water from the open pits, underground operations, and any other site water not reporting to the TMA or the sedimentation ponds associated with specific waste rock stockpiles. The MWP is expected to receive runoff from an approximately 113 ha drainage basin and another 110 ha from the basin created by the open pits. It will provide sufficient storage capacity for three-day retention of the runoff volume from a 10-year 24-hour rainfall storm. The average retention time during a normal precipitation year will be about 20 days. Assuming that water quality criteria are met, the pond will be permitted to discharge continuously through either a low level outlet works or an overflow spillway structure (see **Appendix 2A**, DWG-C0119). For flood events exceeding the 1-in-100-year, 24-hour storm runoff volume, pond water will be allowed to spill through the emergency spillway. Should any constituent monitored at the spillway discharge not meet (IFC, 2007) Table 1 limits, sufficient land area adjacent to the receiving stream is available for the installation of one or more settling or polishing ponds.

The *Water Management Plan* will support and be operated in conjunction with a separate *Tailings Area Management Plan* (see Section 9.3.2.2) that will also be developed during the construction phase of the Project, after completion of final design. It should also be noted that a double-lined 2000 m³ emergency or event pond will also be constructed immediately west of the process facility (see **Appendix 2A**, DWG-C0114). However, this pond will be designed only to receive process solution or tailings on an emergency basis if a vessel in the process facility or tailings pipeline needs to be emptied because of a process upset or repair need that could not be readily accommodated by the process plant's own secondary containment systems. Any solution so retained (and water from any rinse down after such an event) would be pumped back to the process, and not released to the environment.

9.3.2.2 Tailings Management

A conceptual tailings management approach was also developed in (TetraTech, 2013) to address the management of process tailings. This approach will form the technical basis for a comprehensive *Tailings Area Management Plan*, which will also be developed with the assistance of the EPC contractor and documented and administered as an element of the Project ESMS (see Section 7 and **Appendix 7A**).

As noted in Sections 17.6.6 and 18.2.5 of (TetraTech, 2013), the cyanide detoxification circuit in the process plant will be designed to be operated to routinely achieve <0.5 mg/L weak acid dissociated (WAD) cyanide (CN_{WAD}) in the as-deposited process tailings stream. This value corresponds to the 0.5 mg/L CN_{WAD} environmental discharge limit noted in Table 1 of (IFC, 2007) as well as the 0.5 mg/L CN_{WAD} maximum permissible value for discharges to surface water permitted under Standard of Practice 4.5 of the ICMC (ICMC, 2012). Detoxified process tailings will be directed via pipeline to a dedicated TMA constructed approximately 1 km south of the process plant, as depicted in **Figure 9.2-1**. Even though the tailings will already be detoxified to permissible environmental discharge levels, additional degradation of residual cyanide in the as-deposited tails may be expected from exposure to ultraviolet (UV) radiation at the TMA surface, volatilization, and the formation of various metallic cyanide complexes in the tailings mass.¹

The TMA will be constructed in a saprolite basin, with embankments of compacted saprolite as shown in **Appendix 2A**, DWG-C0117. As noted in (AMEC, 2009) and Section 4.5.3 and Table 4.5-4 of this updated ESIA, saprolite has naturally low hydraulic conductivity, which is generally estimated at approximately 10^{-5} cm/s for the Aurora site. The TMA basin is therefore expected to perform as a natural low-permeability lining system. The basin will be subjected to additional geotechnical characterization as part of the final design effort, and an appropriate final basin clearance, preparation, inspection, monitoring, and as necessary, amendment scheme (via localized grouting, placement of compacted clay, or other appropriate method) will be developed in order to resolve any geological inconsistencies that would affect the uniformity of hydraulic conductivity. The conceptual design of the TMA, as defined by (TetraTech, 2013) has also been subjected to an independent engineering review; see **Appendix 9D**. As noted therein, the design was determined to be feasible with no fatal flaws noted

As the tailings solids settle, a supernatant pond will be formed that will be decanted by barge-mounted pumps and recycled back to the mill and process plant for a variety of industrial uses

¹ Based on information provided in the following references; these were also used as data sources in the water quality modeling exercise discussed in Section 9.3.2.3.

- Botz, M. and Mudder, T., 2000. Modeling of Natural Cyanide Attenuation in Tailing Impoundments. *Mineral and Metallurgical Processing*, Vol. 17, No. 4, pp. 228-233.
- Broderius, S.J. and Smith, L.L., 1980. Direction photolysis of hexacyanoferrate complexes: Proposed applications to the aquatic environment. University of Minnesota, St. Paul, p. 12-17.
- Lötter, Nadia, 2005. "Cyanide Volatilization from Gold Leaching Operations and Tailing Storage Facilities", Master's Thesis, University of Pretoria, Pretoria, Republic of South Africa.

(e.g., gland seal water for the ball mills, reagent mixing water, general plant washdown water). Precipitation and runoff are significant in the wet seasons as previously noted, and may be expected to provide significant dilution of the residual cyanide and other constituents in the tailings decant pond. Seepage collection and reclaim pond pumpback systems will also be constructed for the main TMA embankments, details of which will be developed as part of the final design.

The TMA embankments will be raised in three discrete stages (i.e., starter dam, Stage 1, and Stage 2 as shown in **Appendix 2A**, DWG-C0116 and DWG-C0117). At certain stages of TMA development and tailings deposition, and in certain wet-season conditions, excess TMA water may be accumulated and may be discharged through an overflow spillway into TMA Diversion Pond 2 (see **Figure 9.2-1**). This will provide additional dilution prior to discharge into a small tributary creek eventually reporting to the Cuyuni River. TMA Diversion Pond 1 is designed to prevent runoff from flowing into the TMA, and pond overflow will provide another unimpacted source of dilution water to TMA Diversion Pond 2. Should any constituent monitored at the TMA Diversion Pond 2 discharge not meet (IFC, 2007) Table 1 limits, sufficient land area adjacent to the receiving stream is available for the installation of one or more settling or polishing ponds; designs for these options will be further developed as part of the Project's final design effort.

9.3.2.3 Summary of Water Quality Modeling Results

GGI commissioned a modeling study to evaluate the general predicted effectiveness of the preliminary TMA and MWP designs in managing the quality of water discharged to the environment. The results of the study are documented in "Water Quality Modeling for Evaluation of Surface Water and Groundwater Impacts of Aurora Gold Mining Project, Guyana", the full text of which is included as **Appendix 9C** of this updated ESIA. The scope of this study and its results and recommendations are summarized as follows:

- **TMA:** the TMA was modeled over its entire project lifetime in order to develop a better understanding of the potential for seepage or inflows to groundwater as well as discharge concentrations in effluents released to the environment after dilution in TMA Diversion Pond 2. TMA performance in relation to these attributes was modeled using the EFDC² and WMS³ model (for the TMA Diversion Pond 2 surface water discharge) and Visual MODFLOW (with MT3DMS, MT3D99, and SURFACT modules⁴) and WHI Unsat Suite⁵ for groundwater inflow or seepage. A group of modeled effluent constituents were selected that are considered to be representative of the tailings stream as well as the list of constituents of concern presented in Table 1 of (IFC, 2007); these included:

² EFDC US Environmental Protection Agency (EPA) 2002 version, with ENVIRON-modified code

³ WMS Version 9.1 (AquaVeo, 2013)

⁴ Visual Modflow Version 2011 .1 Premium (Schlumberger Water Services, updated 2013)

⁵ WHI Unsat Suite Plus Version 2.2.0.5 (Schlumberger Water Services, updated 2006)

- free and total cyanide (CN_T and CN_F);
- iron (Fe); and
- TSS (from decant water discharged over the spillway to TMA Diversion Pond 2, as well as natural runoff also reporting to TMA Diversion Pond 2).

Modeled concentrations of these constituents were based on the averages obtained from decant water test data published in “Geochemical and Geotechnical Characterization of Guyana Goldfields Mined Tailings (AMEC, 2010), which required the development of representative tailings samples from laboratory scale tests using actual Project ore. Additional mathematical adjustments were made to account for additional degradation of the various cyanide species in the tailings mass due to volatilization, photolysis on the TMA surface from ultraviolet light, and the formation of nonhazardous metallic cyanide complexes.

With respect to groundwater infiltration, a groundwater model was developed using the same (AMEC, 2009) hydrological assumptions presented in Section 4.5.3 and Table 4.5-3; these also formed the basis of the hydrogeological modeling effort documented in **Appendix 9B**.

Numerical models simulating groundwater flows (MINEDW, developed by Itasca, and MODFLOW, developed by ENVIRON) extend from Cuyuni River at the north to the southern edge of the 2013 proposed Tailings Management Area (TMA). Both models incorporated soil test results and pumping data from tests conducted by AMEC between 2009 and 2011, and by SRK in 2012. The majority of these tests were located in and adjacent to the proposed open pit area, with six additional boreholes located near southern boundary of the TMA in its final configuration and location. As noted in the ITASCA modeling report (see **Appendix 9B**), horizontal and vertical hydraulic conductivities (versus distance and depth, respectively) were estimated based on available soil test data. It was generally observed that for unconsolidated deposits, there were no trends or changes of hydraulic conductivity in relation to the distance from Cuyuni River. For weathered bedrock, however, hydraulic conductivity consistently decreased with increased distance from Cuyuni River.

The ENVIRON MODFLOW model used the same hydrologic and hydrogeologic input data as the ITASCA model. At the TMA, results indicate very slow movement of the modeled constituents over time, generally in the direction of the open pits. For example, **Figures 9.3-1 through 9.3-4** show plan and section view representations of a metallic (Fe) transportation in groundwater after two years of operation, and again after 18 years; note that the Fe concentration from (AMEC, 2010) was increased by an order of magnitude to simulate a conservative worst-case scenario. **Appendix 9C** presents additional representations for all other selected constituents at selected stages in mine development, along with a detailed interpretation of groundwater model results and full discussion of the assumed concentrations and the other assumptions upon which the modeling was based.

Figure 9.3-1: TMA Groundwater Infiltration Model: Plan View of Major Project Features

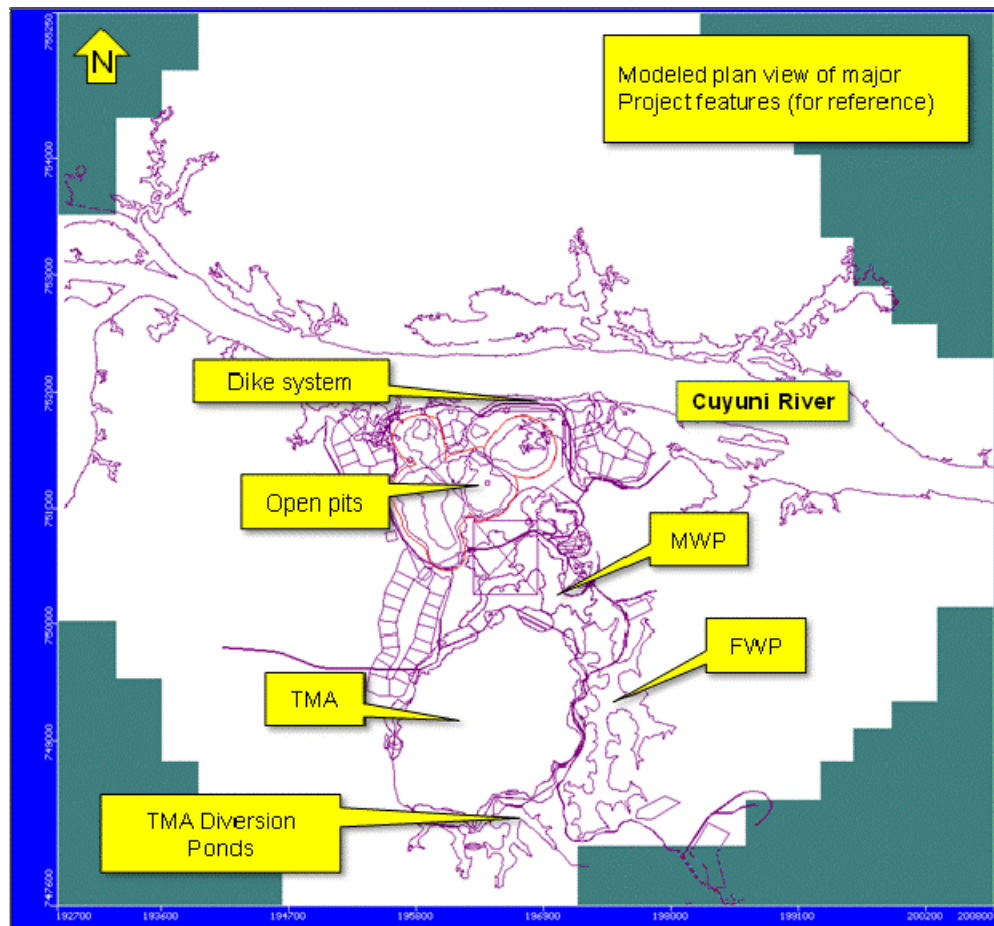


Figure 9.3-2: Comparison of Horizontal Extent of Fe Concentrations (mg/L) in Groundwater beneath TMA, Year 2 and Year 18

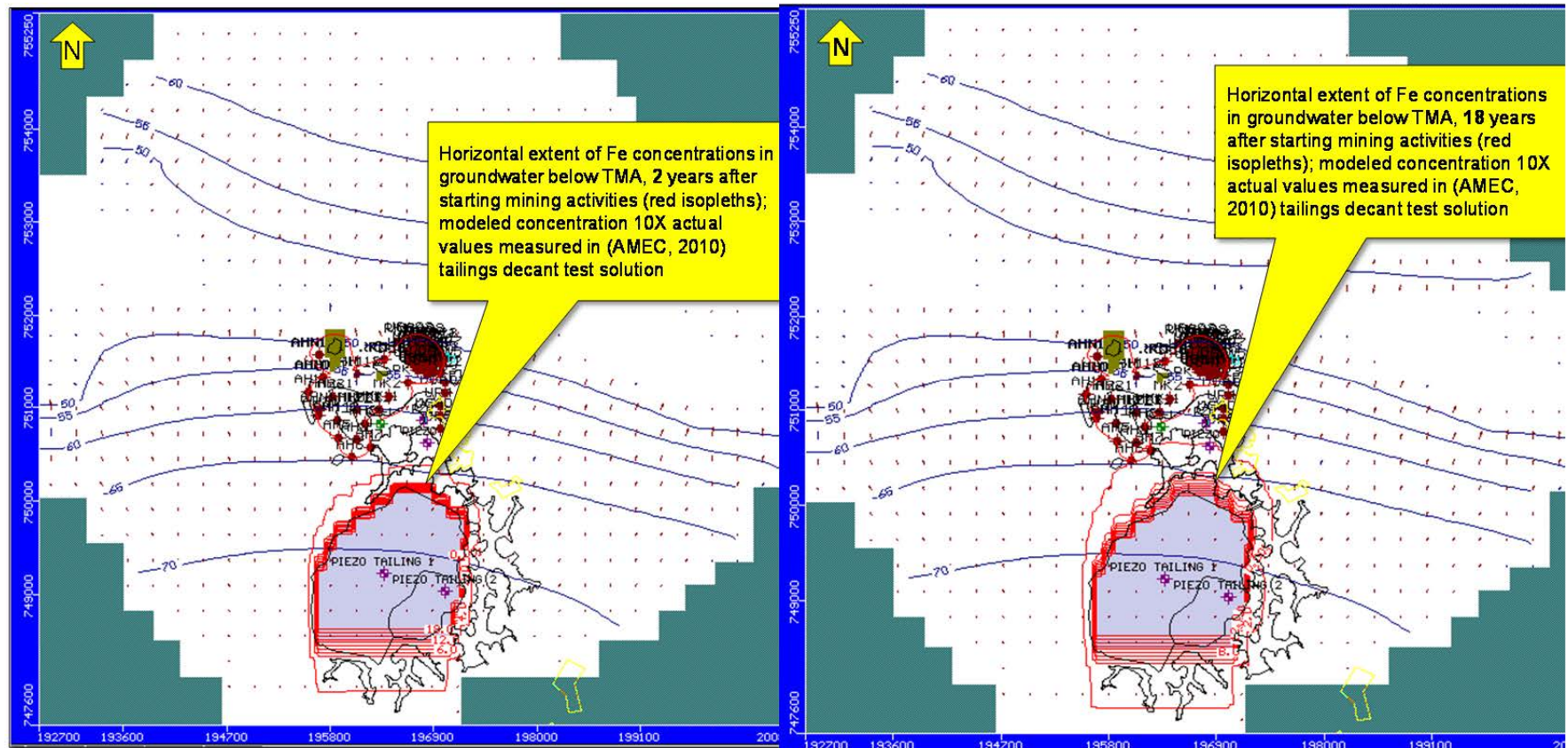


Figure 9.3-3: Location of Sectional Model Views, Vertical Extent of Fe Concentrations in Groundwater (mg/L) at TMA

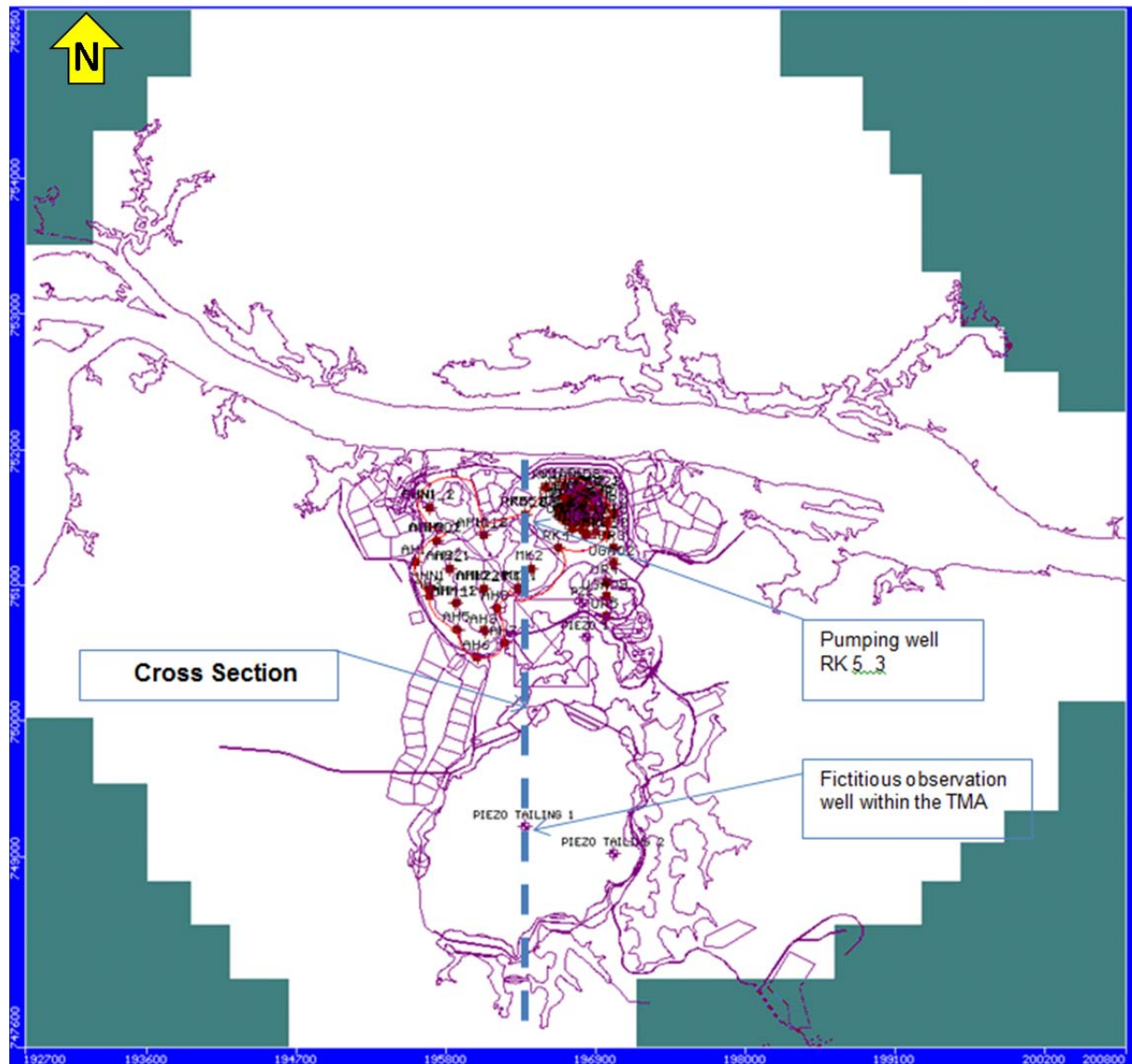


Figure 9.3-4: Comparison of Vertical Extent of Fe Concentrations in Groundwater (mg/L) beneath TMA, Year 2 and Year 18

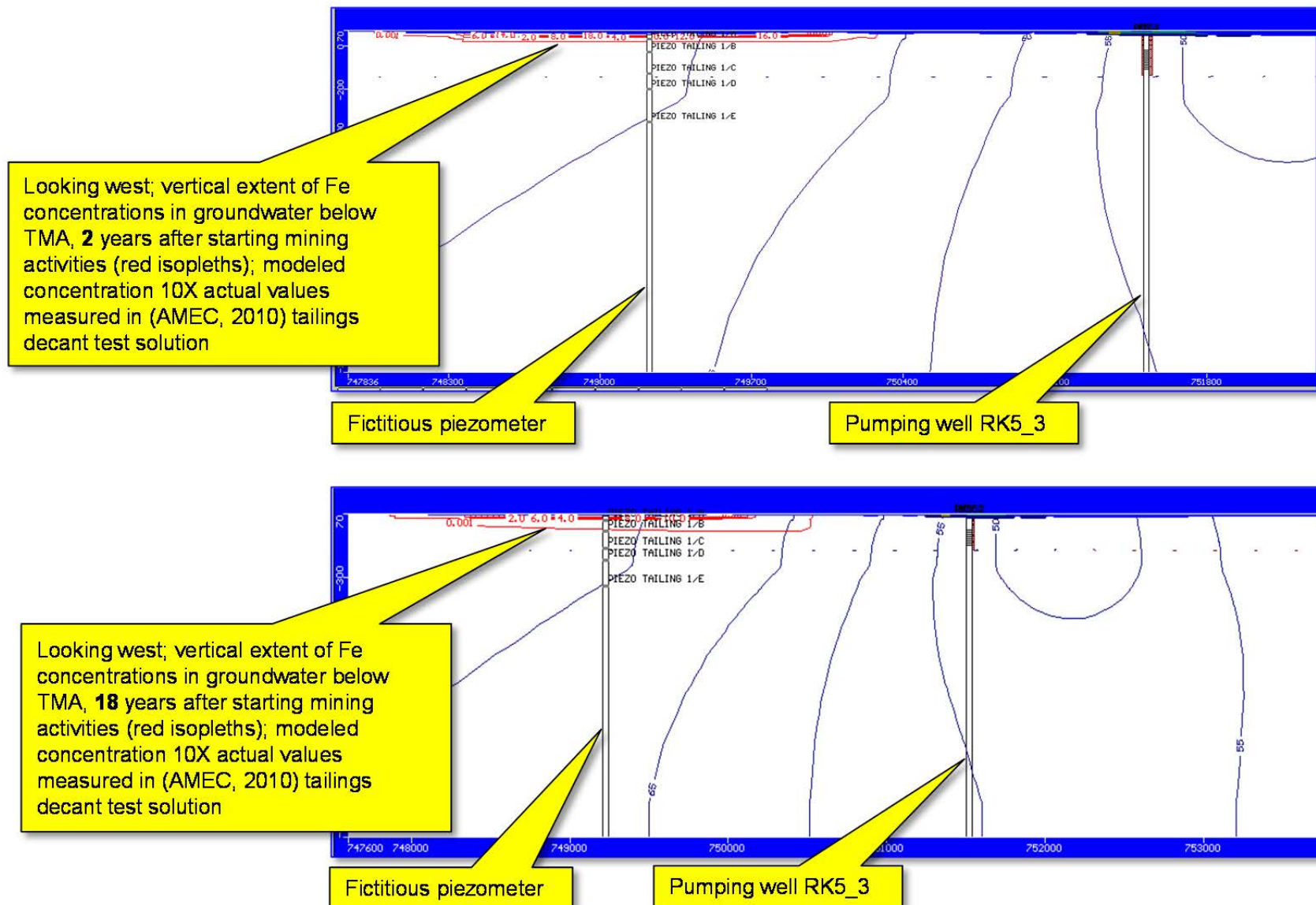


Figure 9.3-5 demonstrates that while Fe and CN_F concentrations are predicted to be well below (IFC, 2007) Table 1 discharge limits (2.0 mg/L and 0.1 mg/L, respectively) without any further dilution, TSS and CN_T concentrations may range higher than their associated limits (50 mg/L and 1.0 mg/L, respectively). The functions of the two diversion and dilution ponds, and TMA Diversion Pond 2 in particular, are therefore confirmed as important components of the overall tailings management strategy.

The performance of TMA Diversion Pond 2 was modeled over the full life of the mine.

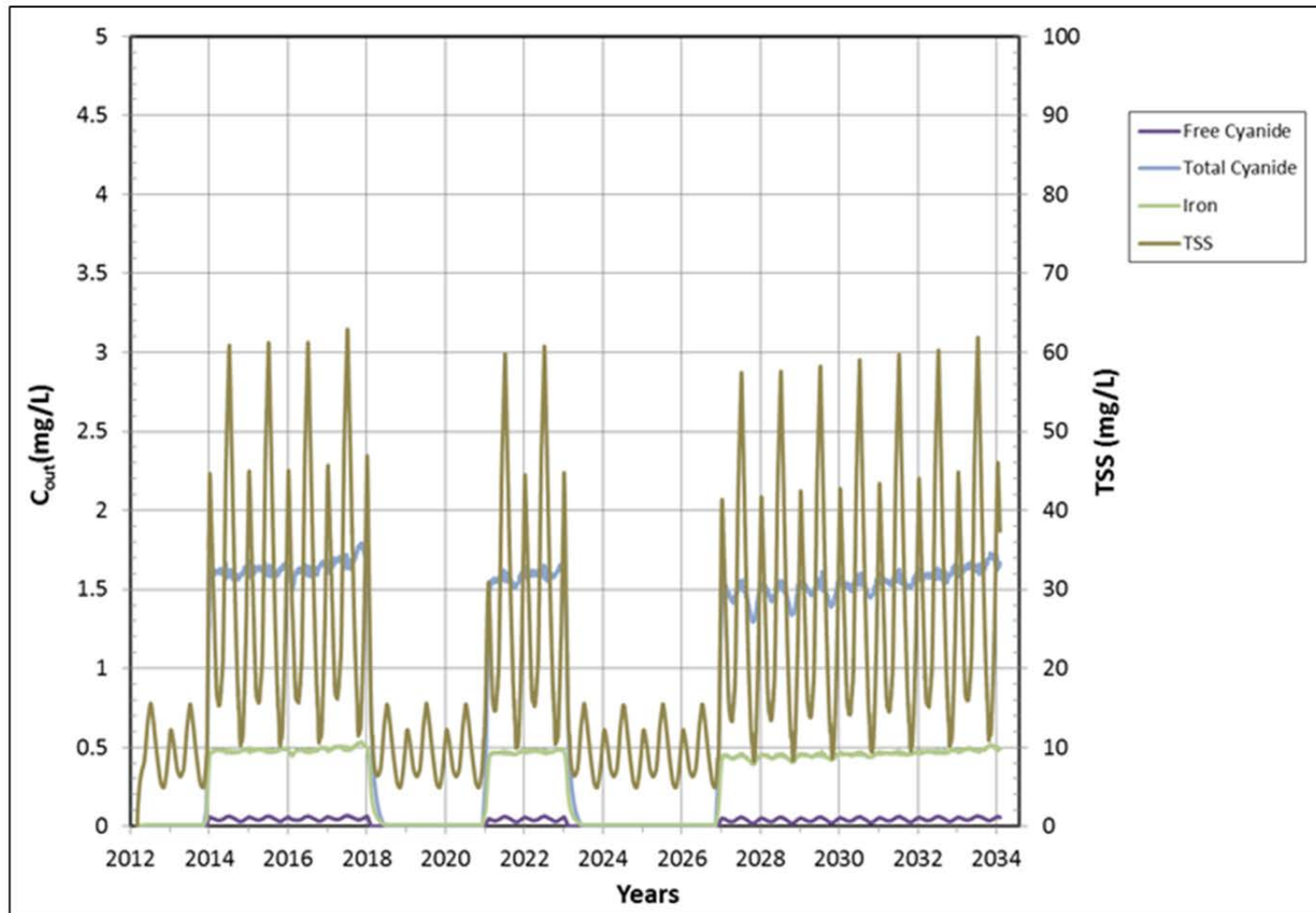
Figures 9.3-6 and 9.3-7 are “snapshots” that illustrate predicted the predicted dilution performance of TMA Diversion Pond 2 with respect to CN_F and TSS concentrations.

The year 1 and year 13 model runs are years in which the TMA is filling (behind the starter dam, for year 1, and behind the Stage 2 raise for year 13) and the spillway is not expected to be operating. Year 2 (simulation year 2014) and year 22 (simulation year 2034) are dilution years, however; the model runs for those years are interpreted as follows:

- **CN_F Distribution in TMA Diversion Pond 2, years 2 and 22;** the model prediction indicates that the volatilization rate of free cyanide is the single predominant parameter that determines the relative discharge concentration (C_{out}/C_{in}) for monthly-average precipitation conditions. CN_F decays quickly below the IFC standard as it spills from the TMA to TMA Diversion Pond 2. Other cyanide complexes and Fe do not volatilize, and adsorption to sediment particles in the water column is estimated to be less than 1 % in total mass. Therefore, the discharge concentrations appear to be primarily controlled by mixing with local runoff and freshwater inflow from TMA Diversion Pond 1. It may also be noted that the spatial distribution of concentrations within TMA Diversion Pond 2 is significantly influenced by combined mechanisms of inflow and average wind-driven circulation. A circulation cell near the TMA spillway appears to elevate the concentrations, as constituents are directly introduced from the spillway overflow. Due to the proximity of the discharge outlet to the TMA spillway, a short-circuiting of the modeled constituent plume may occur in spite of a long average residence time. This short-circuiting effect may become greater for the heavier rainfall condition. A significant amount of fresh water from TMA Diversion Pond 1 dilutes the plume, particularly in the south pond area, but incomplete mixing appears to occur due to low water velocities.

Wind-generated circulation is dominant but very small (< 2 cm/s); sensitivity analysis indicated the wind direction has no notable effect on the discharge concentration.

Figure 9.3-5: Predicated Effluent Discharge Concentrations at TMA Spillway, Operations and Closure/Post-closure Phases⁶



⁶ Note that CN_F , CN_T , and Fe values share the same scale.

Figure 9.3-6: CN_F Distribution in TMA Diversion Pond 2 in Years 1, 2, 13, and 22

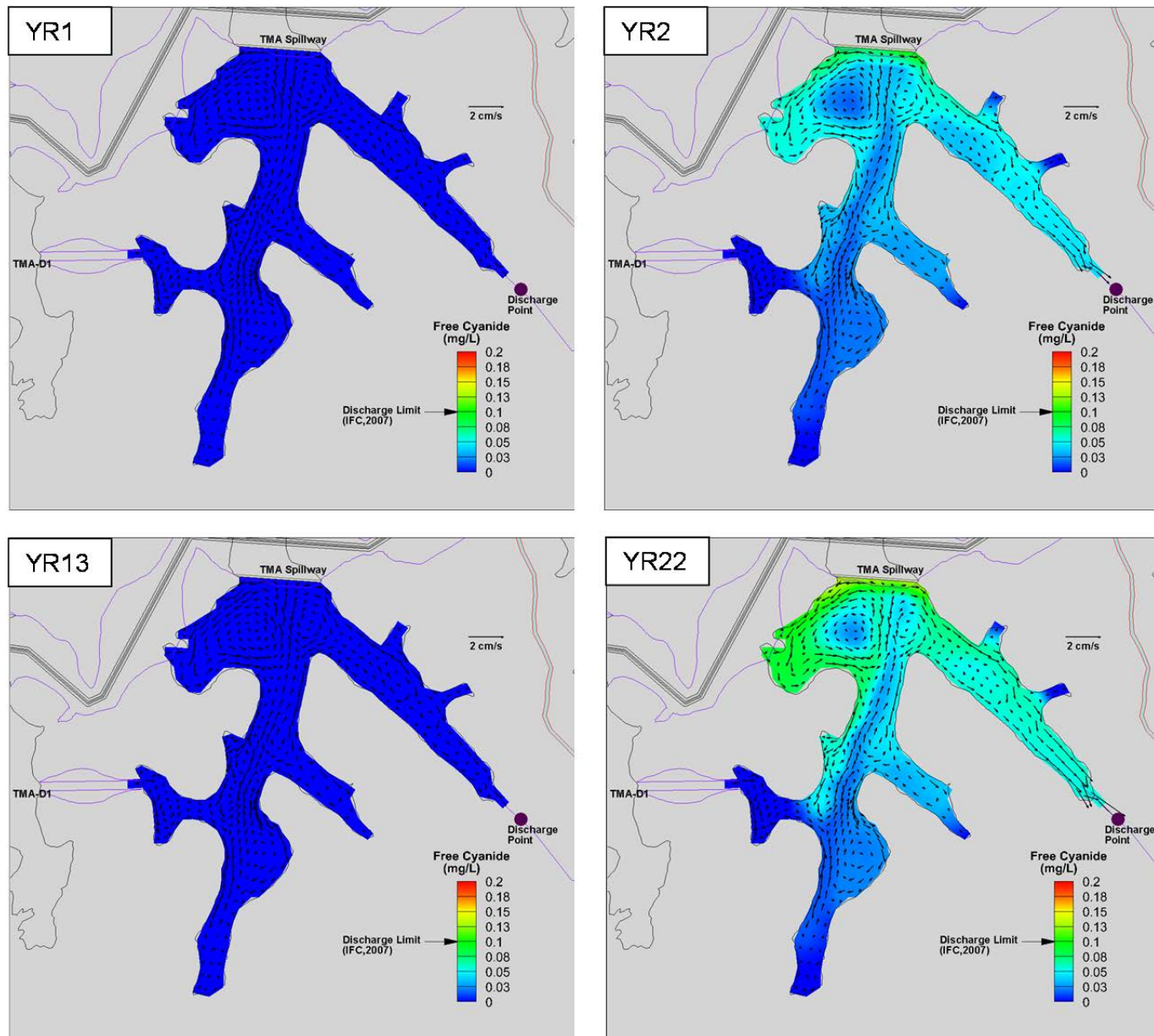
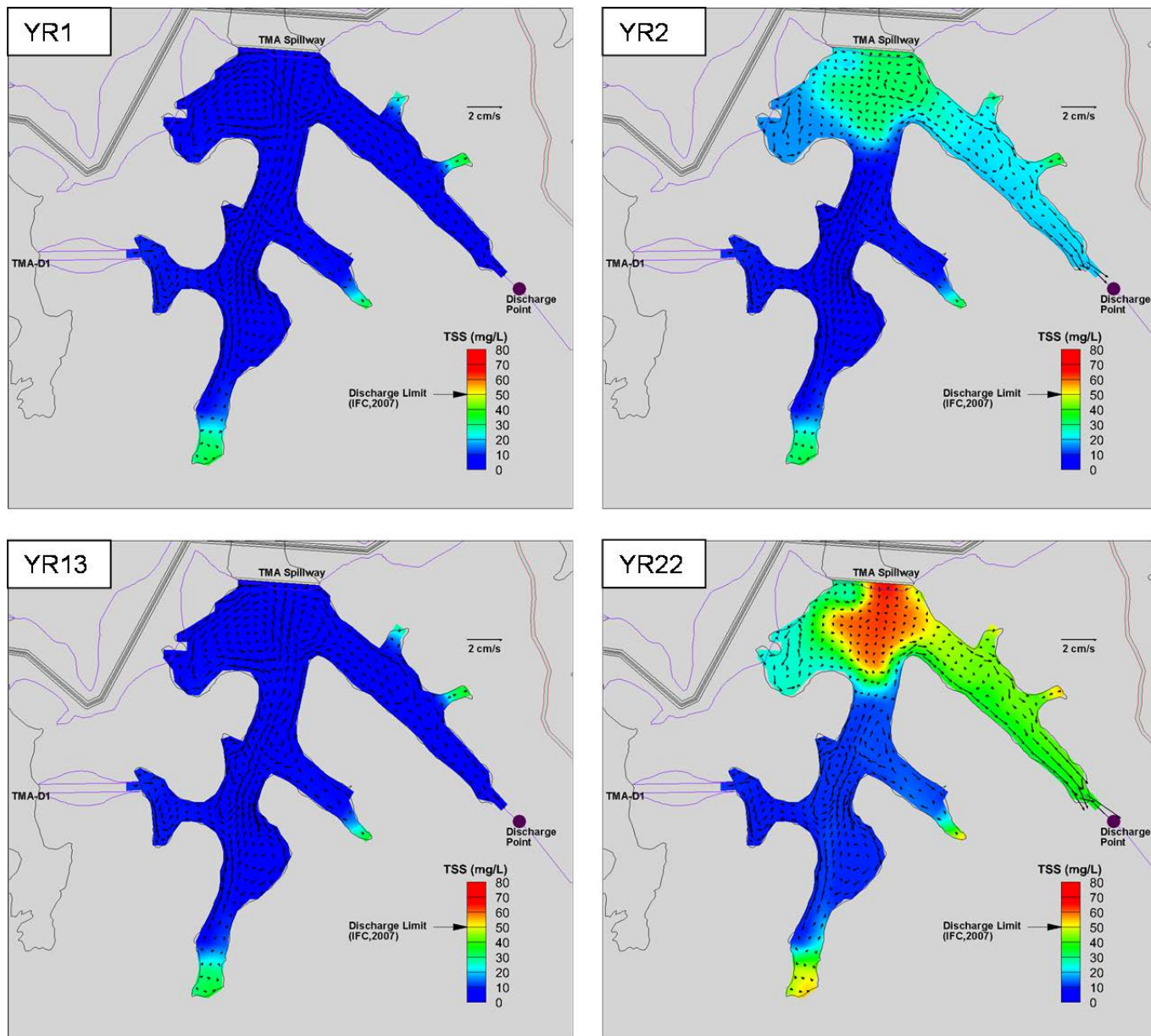


Figure 9.3-7: TSS Distribution in TMA Diversion Pond 2 in Years 1, 2, 13, and 22



- **TSS Distribution in TMA Diversion Pond 2, years 2 and 22;** TSS inputs to TMA Diversion Pond 2 originate with the TMA decant pond as well as local runoff from four channel sources, as noted in **Figure 9.3-7**. The TSS input from TMA Diversion Pond 1 is much smaller due to dilution and deposition within the pond prior to conveyance to TMA Diversion Pond 2. Therefore, the TSS concentration in TMA Diversion Pond 2 is largely due to the mixing of local runoff with fresh water from TMA Diversion Pond 1. During TMA overflow years, a higher concentration of TSS plumes is predicted in the deeper north pond area near the spillway. This area is expected to see higher sediment deposition than any other area of the pond. TSS will deposit along the plume trajectory. A wet season model “snapshot” (e.g., year 22) will typically show a much higher concentration than a dry season equivalent (e.g., year 2).

In summary, the modeling exercise results (see **Appendix 9C** for the full report) indicates that of all the modeled effluent constituents, TSS concentrations are perhaps the most likely to approach discharge limit levels, especially in wet seasonal conditions in which non-tailings inflows are highest. This potential tendency will need to be monitored closely in the as-built TMA facilities, and if worsening trends are noted, establishment of one or more settling ponds downstream of the noted discharge point may be required, subject to confirmation of these modeling results. It is understood that contingency provisions for the installation of additional pond structures will be incorporated into the final design effort.

- **MWP:** The MWP is also constructed in a saprolite basin, with saprolite embankments and a permanent spillway, as shown in **Appendix 2A**, DWG-C0118 and –C0119. Hydraulic conductivity values are expected to be similar to the TMA, as noted in (AMEC, 2009) and Section 4.5.3 and Table 4.5-4 of this updated ESIA. The MWP was also modeled over the entire project lifetime modeled, using the EFDC and WMS mathematical models, in order to develop a better understanding of discharge concentrations in effluents released to the environment from the spillway. Modeled constituents were selected that are representative of the list of constituents presented in Table 1 of (IFC, 2007) for water directly impacted by mining operations. These are presented in **Table 9.3-1**, along with the associated effluent standard from (IFC, 2007).

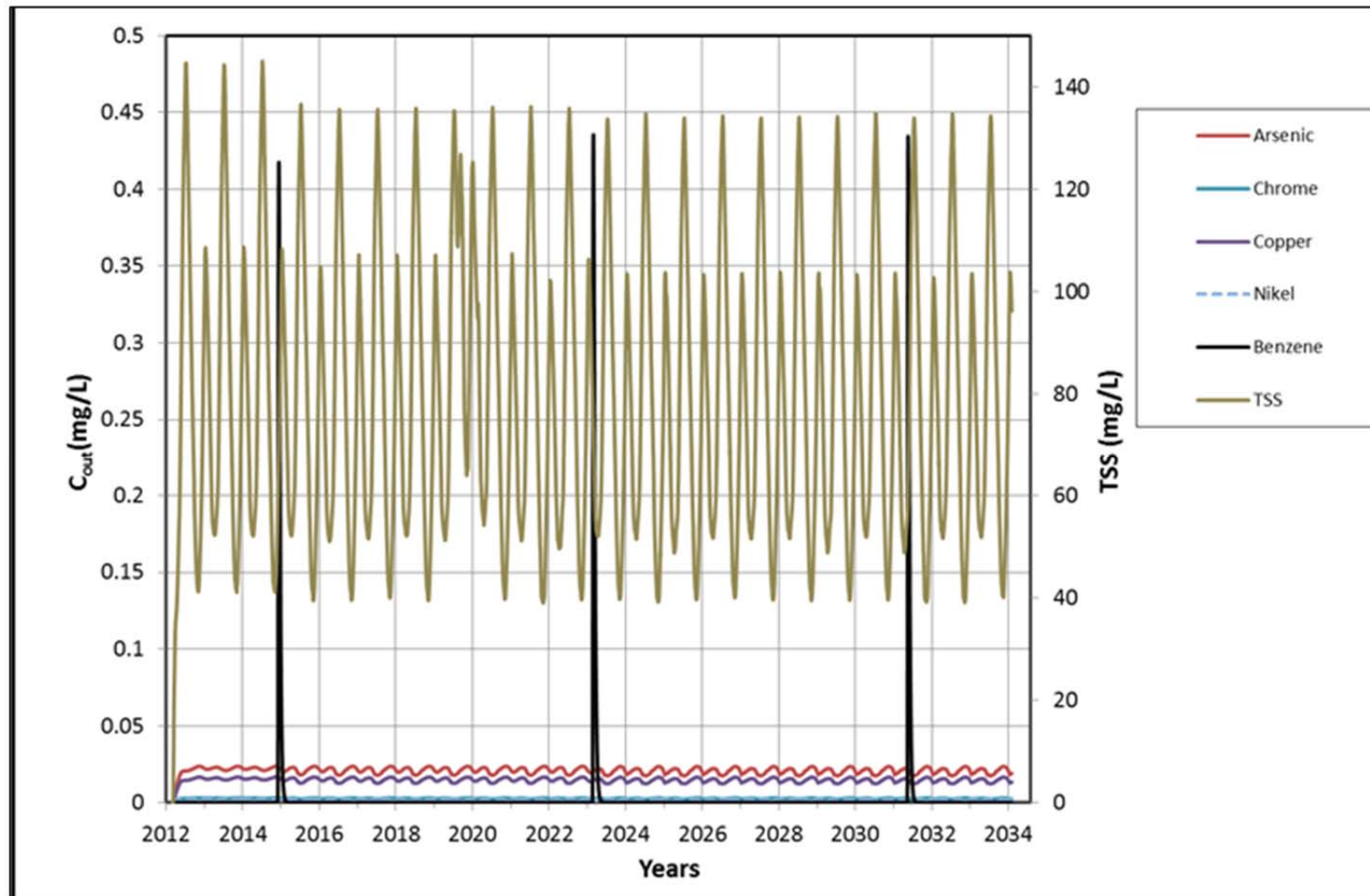
Table 9.3-1: Representative MWP Constituents and Discharge Limits

Representative MWP Constituent	(IFC, 2007) Discharge Limit
Arsenic (As)	0.1 mg/L
Chromium (Cr)	0.1 mg/L
Copper (Cu)	0.3 mg/L
Nickel (Ni)	0.5 mg/L
Benzene (selected as a representative constituent for potential petroleum hydrocarbon contamination)	10 mg/L (total oil & grease)
TSS (from decant water discharged over the spillway and other runoff reporting to the MWP)	50 mg/L

Figure 9.3-8 presents the predicted concentrations of these representative effluent constituents at the MWP spillway, over the life of the mine. With the exception of benzene, these constituents are considered to be representative of the geochemistry of the mineralized areas in the open pits likely to be exposed to meteoric water, runoff, or groundwater inflow as a result of mining operations. Background estimates were derived using average values from the analytical results for dissolved metals in ore and overburden samples appended to “Acid Rock Drainage and Metal Leaching Characterization - Kinetic Test Results” (KCB, 2012); see **Appendix 9B**. For modeling purposes, benzene was assumed to be associated with three hypothetical machinery-based fuel spill events occurring in 2015, 2023, and 2031.

Figure 9.3-8 demonstrates that that average As concentrations are predicted to be about 0.025 mg/L, well below the (IFC, 2007) limit of 0.1 mg/L. Associated model “snapshots” for years 1, 2, 13, and 22 are presented in in **Figure 9.3-9**. TSS input concentrations to the MWP from the pits, local runoffs, and the FWP were estimated based the GSSHA Kilinc-Richardson soil erosion model (Kilinc & Richardson, 1973), from monthly average runoff conditions. For the mined pits, due to sediment trapping effects, 50% of the eroded mass was assumed to enter the sump area from which water would be pumped to the MWP. It was also assumed that clean groundwater seepage would serve to dilute TSS prior to pumping. No sediment deposition loss was assumed in the sump, because all water was assumed to be pumped out. Local runoff and FWP TSS values were also calculated using the same method for soil erosion estimation. TSS overflows from FWP also considered sedimentation in the FWP, which significantly reduced the input TSS values. However, as also noted in **Figure 9.3-8** and **Figure 9.3-10**, although the aforementioned dilution effects were accounted for, modeled TSS values are expected to consistently exceed the (IFC, 2007) 50 mg/L discharge limit, in all wet seasons.

Figure 9.3-8: Predicated Discharge Concentrations of MWP Effluent Constituents at Spillway, Operations and Closure/Post-closure Phases⁷



⁷ Note that AS, Cr, Cu, Ni, and benzene values share the same concentration scale.

Figure 9.3-9: As Distribution in TMA Diversion Pond 2 in Years 1, 2, 13, and 22

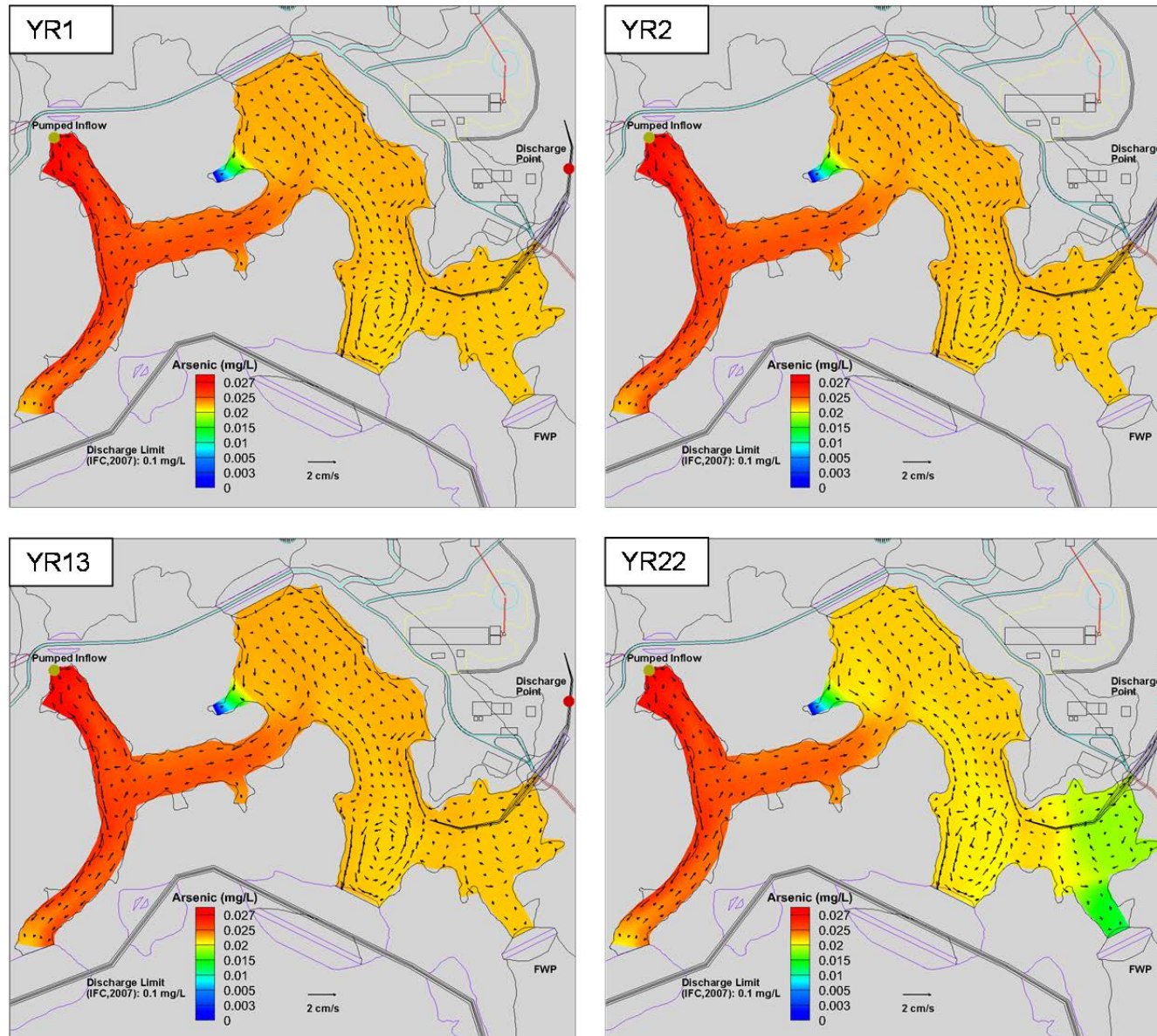
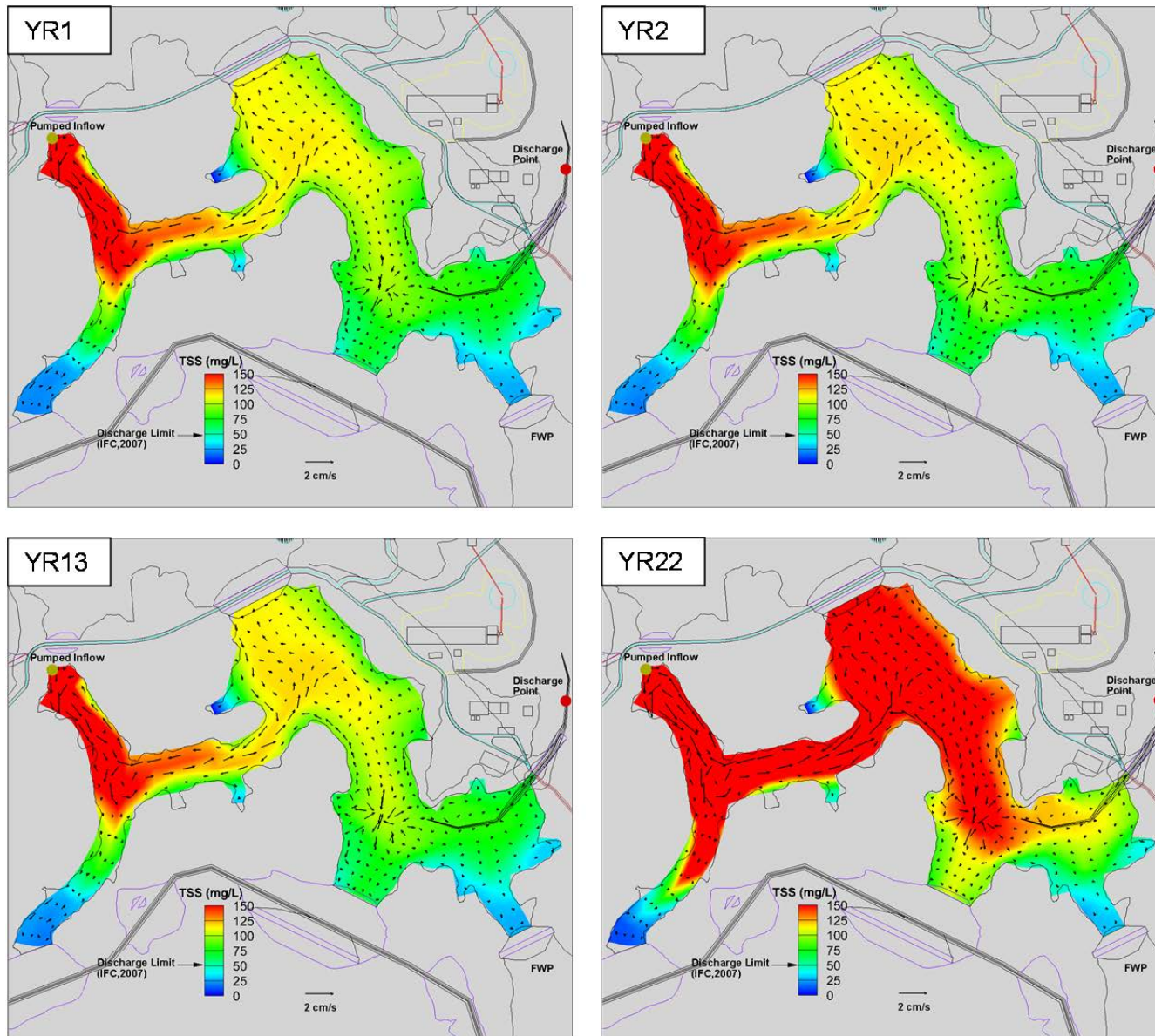


Figure 9.3-10: TSS Distribution in TMA Diversion Pond 2 in Years 1, 2, 13, and 22



The Cr, Cu, and Ni ranges in the MWP were all below the (IFC, 2007) Table 1 discharge limits, over the life of the mine; see **Appendix 9C** for a full presentation of results. For the accidental spill of benzene, the model prediction indicates that the spilled concentration (95 mg/L over a period of 12 hours) is diluted and volatilized quickly and hence well below the IFC standard at the outlet. Other metals (As, Cr, Cu, Ni) do not volatilize. Adsorption of these constituents to sediment particles is estimated to be insignificant relative to the total mass fraction of the water column. Therefore, the modeled discharge concentrations are primarily controlled by mixing with local runoff and inflow from the FWP. The distributions of concentrations of effluent constituents tend to show a gradient from the location of mine pit water discharge in the northwest channel or corner of the MWP. The mixing of constituents within MWP is significantly influenced by combined mechanisms of inflows and average wind-driven circulation (assumed to be a 1.8 m/s north wind). Due to the proximity of overflow from the FWP to the MWP spillway outlet, the dilution near the outlet becomes especially prominent during wet seasons. The wind-generated circulation dominates mixing effects, but has a very low velocity (< 2 cm/s). Sensitivity analysis indicated the wind direction has no notable effects on the discharge concentration.

The MWP was also modeled for potential infiltration to groundwater using MODFLOW and the same hydrological and hydrogeological input data as used in the ITASCA model (see **Appendix 9B**). Results were very similar to those obtained for the TMA. For example, **Figures 9.3-11 through 9.3-13** show plan and section view representations of As transport after two years of operation, and again after 18 years. It should be noted that the As concentration was increased by an order of magnitude to simulate a conservative worst-case scenario. Results indicate that because the MWP is located closer to the open pit areas than the TMA, seepage flow towards the pit is becomes more pronounced with time. **Appendix 9C** presents additional representations for all other selected MWP constituents at selected stages in mine development, along with a detailed interpretation of groundwater model results and full discussion of the assumed effluent constituent concentrations and the other assumptions upon which the modeling was based.

In summary, the background geochemistry of the areas to be mined is such that elevated TSS may also be present in the MWP discharge, due to the large surface areas exposed to groundwater infiltration, meteoric water, and runoff, all of which ultimately reports to the MWP. Results suggest that as the MWP is currently designed, the dilution effects of precipitation plus clean FWP overflow may not be sufficient to bring TSS values down to acceptable limits prior to spillway discharge. However, it must be emphasized that these are modeled results, not actual observed conditions, and are subject to many assumptions as noted in the **Appendix 9C** report. In the development of the final design of the MWP, GGI will therefore prepare optional designs for one or more settling or polishing ponds downstream of the spillway to treat potentially elevated levels of TSS based on further verification and calibration of the model results by the EPC and GGI design team. Water quality monitoring in the MWP and all other water

Figure 9.3-11: Comparison of Horizontal Extent of As Concentrations (mg/L) in Groundwater beneath MWP, Year 2 and Year 18

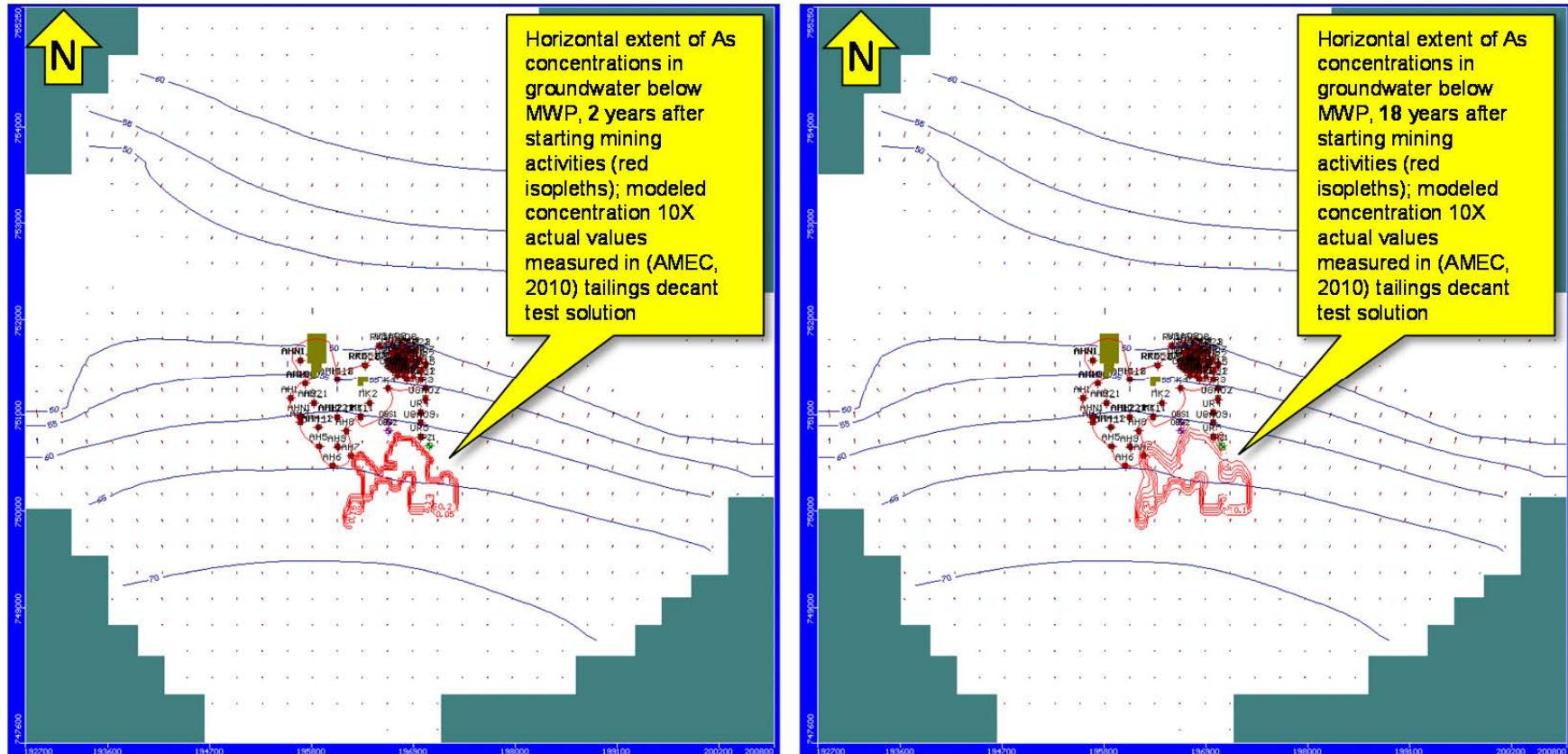


Figure 9.3-12: Location of Sectional Model Views, Vertical Extent of As Concentrations (mg/L) in Groundwater beneath MWP

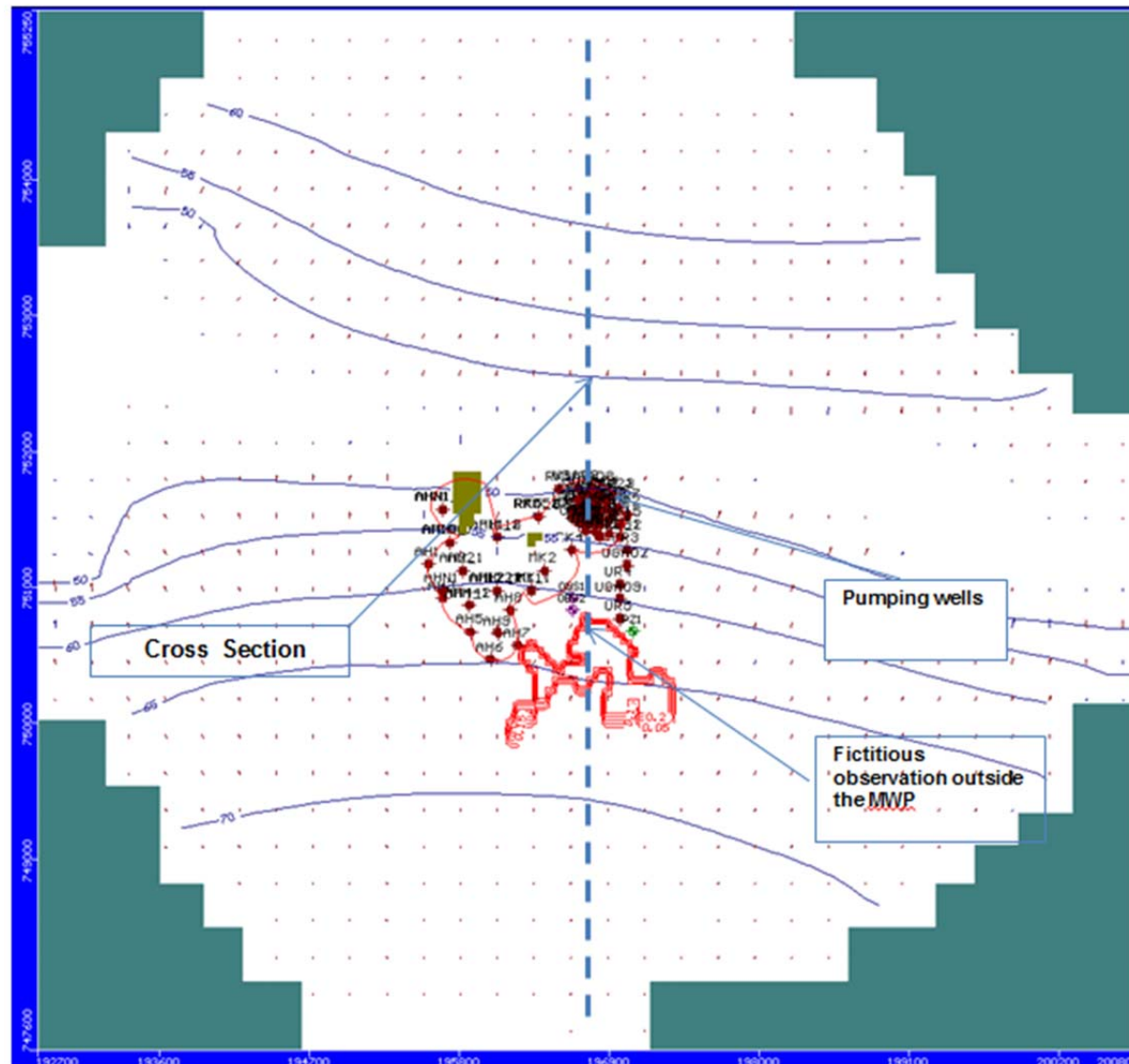
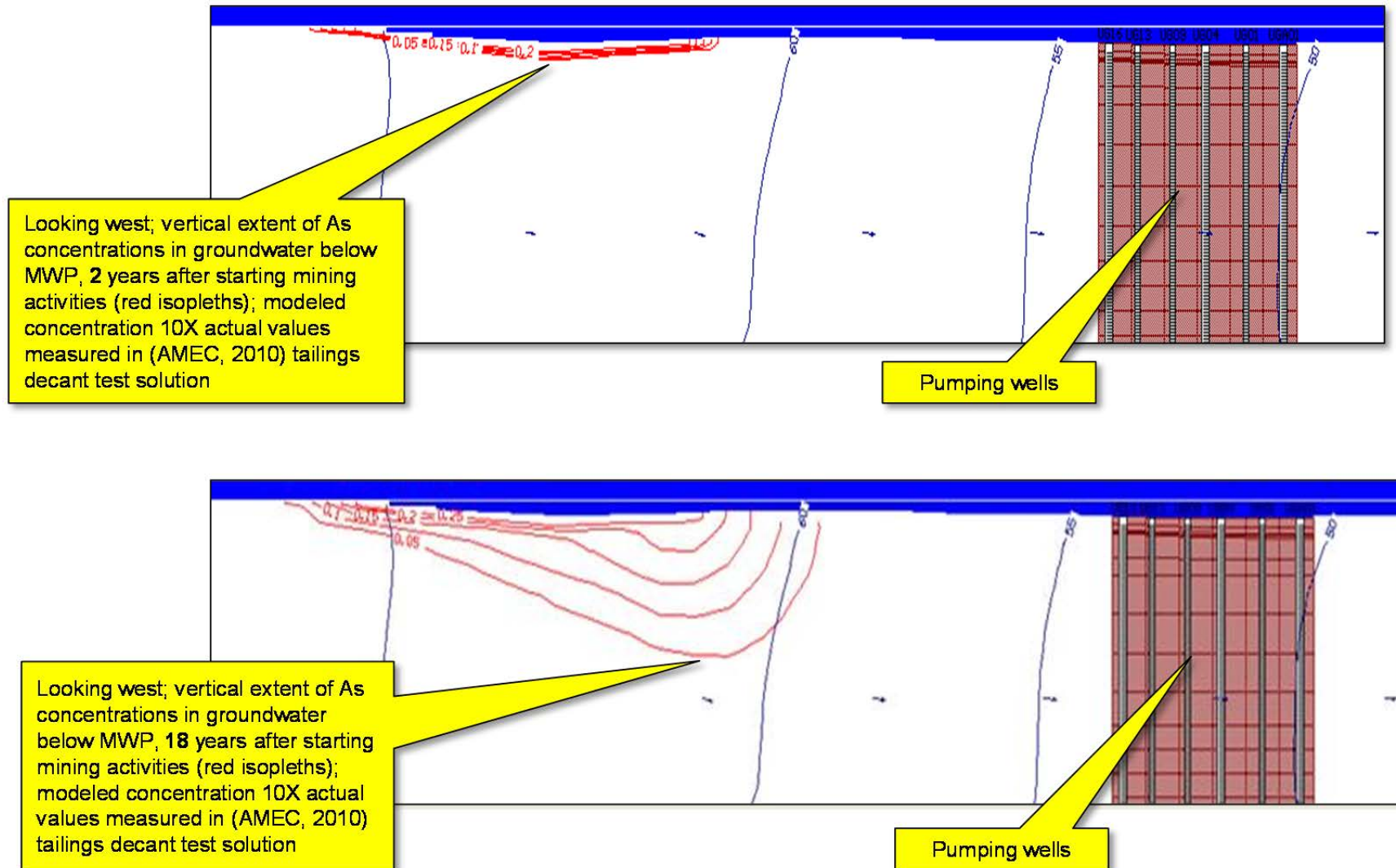


Figure 9.3-13: Comparison of Vertical Extent of As Concentrations (mg/L) in Groundwater beneath MWP, Year 2 and Year 18



management features will be conducted in the operational phase to detect any worsening trends for TSS, As, and all other relevant constituents as listed in (IFC, 2007) Table 1. These requirements will be reflected in the *Water Management Plan* that will be developed to support the operational phase of the Project; see Section 7.2.2.

9.3.2.4 Management of Acid Rock Drainage Potential

Appendix 2A, DWG-N0100 identifies the location of four waste rock stockpiles and one waste saprolite stockpile that will be created near the perimeter of the open pits. Results of geochemical testing (see Section 4.7.3 and **Appendix 9A**) indicate that acid rock drainage (ARD) conditions are not likely to be generated in any of the waste rock stockpiles, with some limited potential associated with one specific area of saprolite. Perimeter drains will nevertheless be installed around the footprint of each prepared stockpile pad, and routed to the MWP or to dedicated settling ponds (see **Appendix 2A**, DWG-N0100) for additional dilution or treatment, as necessary, prior to being permitted to discharge to the environment. Discharge limits will be identical to those used for the MWP [i.e., (IFC, 2007) Table 1]. Monitoring wells and surface water monitoring stations will be installed upgradient of all projected sedimentation pond locations, as also shown on DWG-N0100. Soils in the footprint areas are expected to be predominantly saprolite with naturally low permeability; cleared footprint areas will be inspected and amended as necessary by local compaction or the placement of compacted clay in areas with exposed bedrock. It is understood that sedimentation pond details will be developed as part of the Project's final design.

9.3.3 Land Impact Management Strategy

The Project will adopt additional strategies for minimizing spills or releases of wastes or other hazardous materials to the land surface that could impact the fertility of the land or compromise the quality of surface water or groundwater. These strategies will be periodically evaluated as part of the continual improvement processes established by the Project's ESMS [see Sections 3.2 and 4.1 of the *ESMS Plan* (**Appendix 7A**)]. GGI will continue to systematically seek alternatives that prevent or minimize pollution, while maintaining or minimizing the Project's environmental footprint and any associated environmental and social impacts.

9.3.3.1 Management of Waste Rock and Topsoil

At the Aurora site, topsoil and organic material will be stripped from the footprint areas associated with open pit development; waste rock and waste saprolite stockpile construction; mill, process plant, power plant, mechanical shops, warehouses, and fuel farm construction areas; man-camp construction areas; haul and access roads; and other areas of mine infrastructure. All clearances will be conducted in compliance with procedures designed to minimize environmental impacts (i.e., GG-44, "Management of Land Clearances" and other standard operating procedures as referenced therein; see **Appendix 7C**). Topsoil removal will, in general, be timed such that clearance occurs immediately prior to construction or use, in order to minimize potential erosional issues. Topsoil will be reserved in small stockpiles located as close as possible to the area disturbed, as it will be used in site reclamation and restoration activities. As noted in Section 9.3.2.4 and **Appendix 2A**, DWG-N0100, four waste rock stockpiles and one waste saprolite stockpile will be created. Even though ARD is not expected to be an issue for these materials, toe drains and settling ponds will be provided for each

stockpile to address potential TSS issues in stockpile runoff and to permit treatment or dilution if ARD trends were ever observed in any waste material. Per (TetraTech, 2013) and **Appendix 2A**, DWG-N0102, it is expected that the waste saprolite stockpile will be completely revegetated on closure, along with the top surfaces of the four waste rock stockpiles.

9.3.3.2 Cyanide Management

Significant quantities of sodium cyanide (cyanide) reagent will be regularly consumed in the mineral extraction process, and the implementation of cyanide management practices that are protective of human health and the environment are central to the Project's strategy for preventing or minimizing the potential for cyanide spills to the land surface during the operational and closure phases of the Project. Cyanide has been used in the processing of gold since the 1800s and is widely used internationally. There are no viable options to the use of cyanide for mineral processing at the scale defined by (TetraTech, 2013). Cyanide is highly toxic, however, and although incidents or accidents involving its use are very rare, it does present a significant environmental and human health risk if not managed properly. In keeping with the requirements of Section 1.1 (Environmental – Wastes) in (IFC, 2007), GGI has therefore committed to manage all aspects of cyanide procurement, transportation, and use in accordance with the International Cyanide Management Code (ICMC), and will prepare and implement a comprehensive *Cyanide Management Plan* as an element of the Project ESMS, prior to permitting the delivery of cyanide to the Project; see Section 7 and the *ESMS Plan* in **Appendix 7A**. As noted in (TetraTech, 2013), all cyanide management processes and facilities (i.e., the mineral separation process plant, detoxification plant, tailings pipeline, TMA, and associated infrastructure) will be designed to specifically incorporate the applicable minimum requirements of the ICMC. These will include:

- purchase of cyanide exclusively from an ICMC-certified producer, which, apart from the minimization of potential supply-chain environmental and social impacts, better guarantees purity of product and hence the predictability of usage rates over time;
- transportation of cyanide to the Aurora site exclusively by an ICMC-certified transporter, which ensures that the transporter has the resources and training to allow them to respond quickly and effectively to any spills or accidents that may occur in transit to the Project;
- physical transportation of cyanide reagent to the site as dry briquettes in dedicated stainless steel ISO delivery/mixing containers (see **Figure 9.3-14** as an example); this delivery form is generally recognized as the most intrinsically robust method of cyanide transport, especially where transportation involves crossing oceans/open waterways, and eliminates several cyanide handling and packaging waste disposal hazards common to other delivery forms;
- storage of mixed high-strength cyanide solution separate from acids or other chemically reactive materials;
- construction of all cyanide management facilities using chemically compatible materials;

Figure 9.3-14: Typical Stainless Steel ISO Delivery/Mixing Container (Source: ENVIRON)



- provisions for competent secondary containments for all cyanide solution transfer, mixing, leaching, and detoxification tanks, sized to receive 110% of the largest tank volume plus an appropriate contingency for piping system drainback and accumulated precipitation;
- construction of cyanide storage, leach, and detoxification tank and piping systems in the open air, which effectively eliminates the potential accumulation of HCN gas in workplace breathing zones;
- day to day monitoring and management of the processing plant in accordance with an approved *Mill/Leach Plant Operations Plan*, to be developed during the major construction phase of the Project as noted in Section 1.1 of the *ESMS Plan* (see **Appendix 7A**); this plan will incorporate contractor-produced operations and maintenance manuals for major equipment items as well as necessary elements of the ICMC;
- design provisions that permit routine detoxification of tailings to a nominal target value of 0.5 mg/L CN_{WAD} , as discharged to the TMA;
- design and construction of the TMA and its associated dilution structures to specifically prevent releases to surface water ≥ 0.5 mg/L CN_{WAD} and >0.022 mg/L CN_F ; and
- day to day monitoring and management of the TMA in accordance with the Project *Tailings Area Management Plan*, also to be developed during the major construction phase of the Project as noted in Section 1.2 of the *ESMS Plan* (see **Appendix 7A**).

The conceptual embankment designs (see **Appendix 2A**, DWG-C0116 and -C0117) and the overall conceptual design of the TMA have also been subjected to an independent engineering review. The results of this review are included for reference in **Appendix 9D** and indicate that the design was determined to be feasible, with no fatal flaws noted.

9.3.3.3 Management of Fuel, Explosives, and other Hazardous Materials

Per (TetraTech, 2013), GGI expects to contract the management of all blasting operations and will require the blasting contractor to develop and implement a comprehensive *Blasting Management Plan*, to be administered as an element of the Project ESMS; see Section 7 and **Appendix 7A**. The blasting contractor will also be required to construct magazines and bulk silos for blasting agents, prior to any such agents being transported to the Aurora site to support the operational phase of the Project. As noted in Table 1.2-1, the contractor will also be responsible for obtaining all necessary permits to transport, store, handle, and use explosives from the Guyana Geology and Mines Commission (GGMC) and Guyana Police Force (GPF).

The management of fuel and other hazardous materials are addressed by the Project's *Hazardous Material Management Plan*, and will be assessed for potential performance improvements as part of the processes defined by the Project's ESMS [see Sections 3.2 and 4.1 of the ESMS Plan (**Appendix 7A**)]. All storage tanks will be built to American Petroleum Institute (API) or equivalent standards, and provided with competent secondary containment equal to 110% of the largest contained tank. Fuelling operations (including remote fuelling operations) will be subject to specific spill prevention measures as defined in the *Buckhall Spill Contingency Plan*, the *Spill Prevention, Control and Contingency Plans (Aurora Site)*, and in the standard operating procedures referenced therein (see **Appendices 7B and 7C**). The overall effectiveness of the aforementioned plans and procedures relative to the prevention and control of pollution will be periodically assessed for potential performance improvements as part of the processes defined by the Project's ESMS [see Sections 3.2 and 4.1 of the ESMS Plan (**Appendix 7A**)].

9.3.3.4 Hazardous and Non-Hazardous Waste Management

GGI will adopt a waste management strategy that considers several alternatives (in descending order of preference):

- waste prevention,
- waste minimization,
- waste reuse or recycling (where such options are possible), and
- waste disposal, using methods that are protective of human health and the environment.

This strategy will be reflected in the Project's *Waste Management Plan* (see **Appendix 7B**) and will be periodically assessed for potential performance improvements as part of the processes defined by the Project's ESMS [see Sections 3.2 and 4.1 of the ESMS Plan (**Appendix 7A**)].

Waste disposal is considered the least desirable waste management option. Waste prevention opportunities are relatively limited but can significantly benefit the environmental and social performance of the Project when available (e.g., elimination of the entire cyanide packaging waste stream by specification of reusable intermodal stainless steel mixing/transportation tanks

as noted in Section 9.3.3.2). Waste reuse or recycling is also a highly desirable component of waste management strategy, but as little or no recycling capability currently exists in Guyana, and as the Project is located over 120 km from any significant population centers that could support the development of such capacity, the Project's options are very limited and disposal alternatives must be considered.

Waste segregation is critical to the effective implementation of any disposal strategy. For this Project, such segregation will be based on current Guyanese landfill disposal criteria⁸ and GIIPs for mining exploration⁹ and development and operation [i.e., IFC, 2007)]; segregation categories and management options will therefore include:

- **Municipal Solid Waste;** in accordance with the Guyana EPA landfill criteria, municipal solid waste includes non-hazardous waste generated in households, commercial and business establishments, institutions, and light industrial process wastes, agricultural wastes, and sewage sludge.
- **Other Solid Waste;** per the Guyana EPA landfill criteria, "other" (non-hazardous) solid waste includes agricultural waste, commercial waste, debris, demolition waste, garbage, household waste, non-hazardous industrial waste, inert waste, putrescible solid waste, refuse, residential waste, and rubbish.
- **Special Waste (includes Hazardous Waste);** per the Guyana EPA landfill criteria, special wastes include hazardous wastes, medical waste, shipboard waste, and aircraft waste. No definition of hazardous waste is provided. However, Prospectors & Developers Association of Canada (PDAC) guidance⁹ suggests in the absence of definitive national guidance, the United Nations hazardous waste system classification should be applied. Hazardous wastes are therefore considered to be wastes that are highly ignitable, reactive, corrosive, radioactive, or toxic. It is also understood that hazardous wastes may be in solid, liquid (e.g., waste oil or coolant) or sludge (e.g., waste grease) form. Residues, containers, and packaging materials associated with the use of insecticides and rodenticides are also categorized as hazardous wastes.

No permitted offsite disposal facilities currently exist that would accept Project waste in any of the above categories, with the exception of the hospital in Georgetown that does have a medical waste incinerator that could potentially accept the Project's clinical waste. At present, there are also no permitted hazardous waste treatment and disposal facilities, and insufficient capacity exists for appropriately controlled offsite disposal of municipal and other solid waste. With these constraints in mind, the Project *Waste Management Plan* (see **Appendix 7B**) requires: development and periodic update of a waste stream inventory; monitoring for the development

⁸ "Criteria for the Identification and Approval of Landfill Sites for Solid Waste Disposal in Guyana", (Guyana Environmental Protection Agency - Special Projects Unit, no date)

⁹ Prospectors & Developers Association of Canada (PDAC) "e3-Plus Excellence in Environmental Stewardship e-toolkit (EES)", Version-01 (PDAC, 2009)

of viable metal, petroleum hydrocarbon, and other recycling options in Guyana; and monitoring for economically viable offsite disposal sources for municipal wastes, other solid wastes, and special wastes. In the meantime, however, GGI's strategy for each major waste category will be as follows:

- **Municipal Solid Waste;** GGI will construct, permit, and operate appropriately designed landfills at the Buckhall logistics support facility and at the Aurora site. The landfills will be designed to appropriate GIIPs, and will accept municipal solid waste, as defined above, as well as non-inert "other" solid wastes.
- **Other Solid Waste;** non-inert "other" solid wastes will be routed to the Aurora and Buckhall municipal solid waste landfills; subject to Guyana EPA concurrence, inert waste will be segregated and buried in specially constructed cells in the waste rock stockpiles.
- **Special Waste (includes Hazardous Waste);** medical waste will be accumulated in dedicated containers and periodically sent to the Georgetown hospital medical waste incinerator for disposal. All other hazardous waste will be accumulated in dedicated steel intermodal containers located within the security perimeter at the Aurora and Buckhall sites, and retained in controlled storage pending identification of an appropriately permitted and economically viable hazardous waste disposal facility (or potentially, viable recycling options for certain waste subcategories).

As noted in the Project's *Mine Reclamation and Closure Plan* (see **Appendix 7B**), unless viable recycling options are available at the time of closure, certain categories of inert solid waste from decommissioning activities will be placed in the underground mine prior to mine closure and the filling of the pit lakes. The municipal solid waste landfills constructed and operated at the Buckhall and Aurora sites will both be closed, capped, and revegetated.

9.4 Management of Pesticides

With respect to PS 3 concerns over the use of pesticides, GGI's primary use of pesticides is in support of its malaria suppression program. Malaria and other mosquito-borne diseases are a significant health risk at both the Buckhall and Aurora sites, and GGI has operated a suppression program in collaboration with the Guyana Ministry of Health ever since it acquired the concession in 1998.

GGI will continue to monitor Guyana Ministry of Health policies in view of relevant international research efforts, and will collaborate with the Ministry of Health in undertaking appropriate improvements to the suppression program as may be warranted by current and scientifically validated GIIPs.

As far as controlling human vectors that could provide reservoirs from which potential outbreaks could develop (which would prompt needs for pesticide use in emergency fogging actions), medical screening practices are in effect (see SOP GG-10, "Prevention and Monitoring of Communicable Diseases") that require a physical examination and malarial blood tests as a condition of employment, as well as onsite monitoring of outbreak symptoms. Site visitors and

returning employees rotating to the Aurora and Buckhall sites are also required to have a blood test for malarial parasites prior to travel.

GGI also periodically deploys limited quantities of prepackaged rodenticides to manage rodents that may be attracted to the food storage and preparation facilities located near the Buckhall and Aurora site canteen areas, or to the solid waste landfills at the Buckhall and Aurora sites.

All residues, containers, and packaging materials associated with the use of insecticides and rodenticides are categorized as hazardous waste, and will be segregated and stored pending identification of a licensed hazardous waste disposal facility, as noted in the *Project Waste Management Plan*; see **Appendix 7B**.

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Section 10:
Community Health, Safety and Security (Ref: IFC PS 4)

Contents

	Page
10 Community Health, Safety, and Security	10-2
10.1 Summary of PS 4 Requirements	10-2
10.2 General Considerations - Health and Safety of Affected Communities	10-2
10.3 Safety Considerations in Infrastructure and Equipment Design	10-6
10.4 Hazardous Materials Management	10-9
10.5 Adverse Community Health and Safety Risk in Provisioning and Regulating (Ecosystem) Services	10-12
10.6 Community Exposure to Disease	10-13
10.7 Emergency Preparedness and Response	10-14
10.8 Security Services	10-15

List of Figures

Figure 10.2-1: Aurora Gold Project AOI – Aurora Site to Buckhall

Figure 10.3-1: Typical Stainless Steel ISO Delivery/Mixing Container

10 Community Health, Safety, and Security

10.1 Summary of PS 4 Requirements

Performance Standard (PS) 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. In addition, communities that are already subjected to impacts from climate change may also experience an acceleration and/or intensification of impacts due to project activities. While acknowledging the public authorities' role in promoting the health, safety, and security of the public, this PS addresses the project proponent's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups.

The specific objectives of this PS are:

- to anticipate and avoid adverse impacts on the health and safety of the affected communities throughout project life, from both routine and nonroutine circumstances; and
- to ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles, and in a manner that avoids or minimizes risks to the affected communities.

Impact management and mitigation measures have been developed to achieve the objectives of PS 4, as applicable to the environmental and social setting of the Aurora Gold Project (Project). The selection of these management and mitigation measures considers relevant aspects of "Environmental, Health and Safety – General Guidelines" (IFC, 2007a); "Environmental, Health and Safety Guidelines for Mining" (IFC, 2007b), the International Cyanide Management Code [ICMC; see (ICMI, 2009)] and other good international industry practices (GIIPs) currently implemented by the international mining industry. These measures are summarized in **Table 6.3-1**, and, insofar as PS 4 issues may be concerned, are further discussed in the following paragraphs.

10.2 General Considerations - Health and Safety of Affected Communities

As noted in Section 5.5.1, only two "affected communities" have been identified within the Project's direct area of influence: Aranka Mouth and Buckhall. Although no detailed studies of climate change impacts specific to these two communities are known to have been conducted, GGI understands the Government of Guyana's interests in the potential effects of climate change, especially as they may relate to the frequency and severity of flooding in low-lying river areas, the availability of drinking water from precipitation collection sources, agricultural productivity, and other potential issues involving human health and well-being. In keeping with the overall objectives of Guyana's current Low Carbon Development Strategy¹, the overall design of the Project includes consideration of a number of issues closely related to climate change concerns. GGI has also established a sustainable approach to mine construction,

¹ See "Low-Carbon Development Strategy Update: Transforming Guyana's Economy While Combating Climate Change" (Republic of Guyana – Office of the President, 2013).

operation, and closure that is embodied in a Project-specific Environmental and Social Management System (ESMS) that complies with PS 1, as discussed in Section 7.0. Within the overall management context so established, GGI has:

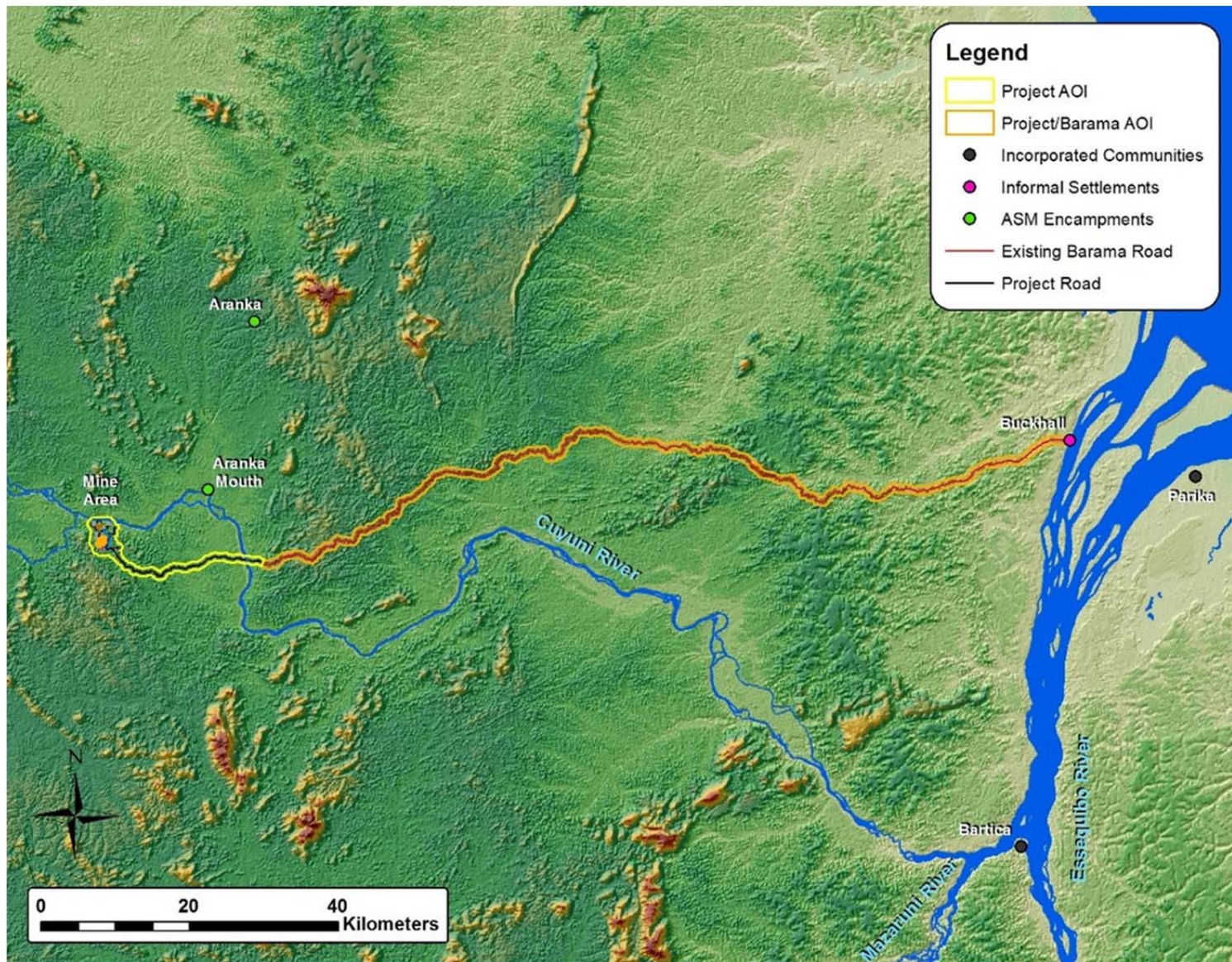
- minimized the overall environmental clearance footprint of the Project over earlier design alternatives, as noted in Section 3;
- implemented revegetation and other erosion control efforts on the rights of way (ROWS) of the newly constructed access road to the Aurora site, in keeping with the requirements of the Project's *Erosion Prevention and Control Plan* (see **Appendix 7B**) and specific IFC recommendations;
- developed a preferred alternative (also discussed in Section 3) that avoids the use of unblended heavy fuel oil (HFO) or conventional (dam plus reservoir) hydropower generation methods, both of which could potentially generate substantial greenhouse gas (GHG) emissions²;
- developed plans for the progressive restoration/revegetation of waste rock/waste saprolite stockpiles, as discussed in the *Mine Reclamation and Closure Plan* (see **Appendix 7B**); and
- committed to establishing greenhouse gas (GHG) monitoring and reporting procedures as part of the *Air Quality Management Plan*, which is slated to be developed and implemented prior to the operational phase of the Project as noted in Section 1.2 of the *ESMS Plan* (see **Appendix 7A**).

GGI will also seek other means of minimizing GHG emissions and minimizing or mitigating other environmental and social impacts deriving from Project activities that could contribute to global warming, on a continuing basis over the life of the Project. This will be achieved through the implementation of the environmental and social performance improvement processes described in *ESMS Plan* Sections 4.1 and 4.2 and the SOPs cited therein (see **Appendix 7A**).

Since primary access to the mine site will be via the access road from Buckhall, the community of Aranka Mouth (located 16 km downstream from the Aurora site on the Cuyuni River and approximately 10 km north of the road from Tapir Crossing to the Aurora site) will never be directly impacted by mine traffic (**Figure 10.2-1**). River travel between Tapir Crossing and the Aurora site is expected to be limited to occasional transportation of exploration personnel and light equipment in small outboard motorboats. No unauthorized contact by the GGI or contractor workforce with the community at Aranka Mouth will be permitted. Travel will be

² Pursuant to recommendations made in Section 1.14 of the most recent NI 43-101 Technical Report (TetraTech 2013), as the project enters the operational phase, GGI may also conduct additional tradeoff studies in an effort to further minimize the costs and the environmental and social impacts of power generation.

Figure 10.2-1: Aurora Gold Project AOI – Aurora Site to Buckhall



restricted to periodic formal community relations contacts by authorized personnel only, organized and implemented in accordance with the Project's *Community Relations Management Plan* and *Influx Management Plan*. The full text of the initial iterations of these plans is included in **Appendix 7C**. They will be administered and periodically updated within the context of the Project ESMS as described in Section 7.

In contrast to the circumstances at Aranka Mouth, the community of Buckhall is immediately adjacent to the GGI river port and secure logistics support and staging area and will therefore be impacted on a day-to-day basis by a variety of environmental and social issues. These issues will be related primarily to river port activity, concentrations of vehicular traffic, and the routine transportation of materials, equipment, personnel, and consumables via daytime truck convoys to the mine site over the access road depicted in **Figure 10.2-1**. It should also be noted that the terms of the Environmental Permit issued for the Project (Guyana EPA, 2010) require that GGI actively discourage influx to the mining concession. Since Buckhall is the "gateway" to the concession, certain measures to minimize influx must be observed in the interaction between GGI's concession area and the local community. Direct interactions between GGI personnel and contractors and the local community will therefore be restricted to employees or contractors whose families may live in or near Buckhall or to those personnel specifically authorized to organize or conduct periodic formal community relations contacts in accordance with the Project's *Community Relations Management Plan* and *Influx Management Plan*. As a matter of policy, no hiring of employees or purchasing of goods or services will be permitted at Buckhall. Potentially qualified applicants or merchants will be encouraged to apply or make contact through GGI's headquarters office in Georgetown. Interactions with the community will be limited to certain types of legal commerce (e.g., purchasing of a limited range of foodstuffs, personal items, or consumer goods) mutually agreed upon by community residents with the concurrence or approval of any affected governmental agencies. If local residents consider these general rules to be too restrictive in providing appropriate access to employment or opportunities for legitimate commerce, they will have access to the Community and Environmental Grievance Procedure appended to the *ESMS Plan* (see **Appendix 7A**), for appropriate redress. No illegal activities on the part of GGI employees or contractors will be permitted, as noted in the Project's Labour Grievance Procedure, which is also appended to the *ESMS Plan*. More specifically, no interactions involving the purchase or sale of alcohol by GGI or contractor employees will be permitted at Buckhall, as alcohol is not permitted on GGI property or in GGI or contractor vehicles.

Although not considered an affected community *per se*, legal and illegal artisanal and small-scale mining (ASM) operations are expected to persist in areas within and outside of the Project's area of influence (AOI). In keeping with the terms of GGI's current Environmental Permit (Guyana EPA, 2010), ASM activities will be the subject of continual monitoring and appropriate actions pursuant to the Project's *Influx Management Plan* in order to discourage ASM access to the Project concession and to generally minimize the attractiveness of the Project to uncontrolled opportunistic or illegal commerce or other criminal activities.

With respect to other potentially vulnerable groups that may be affected by the Project, the nearest Amerindian community (Kurutuku) is approximately 40 km upstream from the project site, and, as noted in Section 5, is not considered to be directly impacted by the Project. Except

for organized community relations/outreach contacts or encounters with occasional Amerindian groups traveling downstream on the Cuyuni River, the potential for interaction with this community is expected to be relatively limited. When such interactions do occur, they will be managed in strict accordance with the Project's *Community Relations Management Plan* and *Influx Management Plan*.

10.3 Safety Considerations in Infrastructure and Equipment Design

Safety risks to the Buckhall community and to transient groups or individuals will be managed primarily by physical exclusion from the various industrial hazards associated with Project operations and by design and construction of mine infrastructure and support facilities in accordance with current GIIPs for mines of this type. Gated security fences will be installed on the perimeter of the Buckhall site and around key areas of Project infrastructure, with access managed by GGI security personnel in accordance with SOP GG-40, "Site Security" (see **Appendix 7C**). All security arrangements, facilities, and structures will be designed and constructed in accordance with GIIP by GGI's licensed "engineer, procure, construct" (EPC) contractor and properly licensed subcontractors. Fenced areas will be patrolled by GGI security personnel on a daily basis to ensure that residents (Buckhall only), ASM workers, or other transient groups do not gain access to restricted or industrial areas. Convoys to the mine site will likewise require the monitoring of roadways in accordance with the GGI *Transportation Management Plan* (see **Appendix 7B**) for temporary encampments or other signs of human intrusion, evidence of which will be investigated and appropriately addressed in accordance with applicable *Community Relations Management Plan* and/or *Influx Management Plan* requirements (see also **Appendix 7B**).

Except in cases of medical or humanitarian emergency, or as may be permitted by an organized community relations outreach action, members of the general public or transient groups or individuals will not be permitted access to major areas or elements of Project infrastructure. At Buckhall, all of these areas will be within the gated and fenced security perimeter of the GGI logistics center, and include:

- GGI port facilities on the Essequibo River, including the fuel trestle and wharf area;
- fuel pipelines, storage tanks, and associated fuelling island;
- warehouses and shops;
- marshaling yard for the organization of truck convoys;
- man-camp, administrative, and canteen buildings;
- rainwater collection/potable water systems;
- equipment laydown areas;
- septic system;
- hazardous waste accumulation/storage containers;
- permitted solid waste landfill; and
- trucks, trailers, and support vehicles.

Access to (or passage on) the Tapir Crossing ferry or barge by unauthorized personnel will likewise not be permitted.

Although there are no affected communities adjacent to the Aurora site, barriers, warning signs, and/or GGI security patrols will be established to prevent or restrict exposure by transient groups or individuals to the industrial hazards associated with key Project components, including:

- the open pit and underground mine work areas;
- trucks, trailers, loaders, drill rigs, and support vehicles.
- haul roads and waste rock stockpiles;
- the run of mine (ROM) ore stockpile;
- crushers, conveyors, and the mill facility;
- hazardous materials warehouses;
- cyanide mixing area and storage tank, leach tanks, detoxification circuit, and associated process components;
- tailings and reclaim water pipelines;
- the Tailings Management Area (TMA), Fresh Water Pond (FWP), Mine Water Pond (MWP), the two TMA dilution ponds, upgradient diversion structures, and downgradient sedimentation ponds;
- explosives magazine/ammonium nitrate and fuel oil (ANFO) silos;
- meteorological station;
- fuel pipeline, storage tanks, and fuelling island;
- heavy equipment ready line;
- warehouse or machine shop areas;
- rainwater collection/potable water systems;
- equipment/cargo laydown areas;
- man-camp, administrative, and canteen buildings;
- septic system/wastewater treatment plant;
- the hazardous waste storage container area;
- inert waste disposal cells and solid waste landfill;
- the two Cuyuni River dykes;
- the airstrip and aircraft support area between the dykes and the Cuyuni River; and
- the river landing near the airstrip.

As noted in Section 9.7, all cyanide management processes and facilities will be designed to specifically incorporate the applicable minimum requirements of the ICMC (see ICMI, 2009). These will include:

- purchase of cyanide exclusively from an ICMC- certified producer;
- transportation of cyanide to the Aurora site exclusively by an ICMC-certified transporter;
- physical transportation of cyanide reagent to the site as dry briquettes in dedicated stainless steel ISO delivery/mixing containers (generally recognized as the most intrinsically safe method of transport, where transportation involves crossing waterways (**Figure 10.3-1**);

Figure 10.3-1: Typical Stainless Steel ISO Delivery/Mixing Container



- storage of mixed high-strength cyanide solution separate from acids or other chemically reactive materials;
- construction of all cyanide management facilities using chemically compatible materials;
- provisions for competent primary and secondary containments for all cyanide solution transfer, mixing, leaching, and detoxification tanks, sized to receive the largest contained tank volume plus an appropriate contingency;
- construction of cyanide storage, leach, and detoxification tanks and piping systems in the open air, which effectively eliminates the potential accumulation of hydrogen cyanide (HCN) gas in breathing zones;

- provisions for detoxification of tailings to a nominal target value of 0.5 milligrams per liter (mg/L) weak acid dissociable (WAD) cyanide (CN_{WAD}), as discharged to the TMA;
- design and construction of the TMA and its associated dilution structures to prevent releases to surface water ≥ 0.5 mg/L CN_{WAD} and >0.022 mg/L CN_{Free} ;
- day to day management of the TMA in accordance with the Project *Tailings Area Management Plan*, to be developed during the major construction phase of the Project as noted in Section 1.1 of the *ESMS Plan* (see **Appendix 7A**.)

The embankments and overall conceptual design of the TMA have also been subjected to an independent engineering review. The results of this review are included for reference in **Appendix 9D**; the conceptual design was determined to be feasible with no fatal flaws noted.

As noted in Sections 9.2, roadways to the Aurora site from the end of the Barama Road (see **Figure 10.2-1**) were built in general conformance with the Guyana Forestry Commission (GFC) “Code of Practice for Timber Harvesting” (GFC, 2002), with erosion prevention and corrective actions/control measures applied in accordance with the *Erosion Prevention and Control Plan* as required to maintain safe driving conditions. The *Transportation Management Plan* governs the organization of daytime convoys of equipment and materials to the site, and includes provides for pilot vehicles, speed limits, driver qualifications, and required driving behavior, and use of appropriate precautions in habitated areas of the road. The *Transportation Management Plan* is supported by a number of SOPs that are designed to minimize the potential human health and safety hazards associated with transportation. These include GG-13, “Transportation Safety – Light Vehicles”; GG-14, “Forklift Safety”; and GG-16, “Safe Operation of Heavy Equipment”, each of which establishes GGI operator training and licensing requirements, speed limits, vehicle maintenance considerations, and other basic rules for safe operation.

Copies of the first iteration of the Project *Erosion Prevention and Control Plan* and *Transportation Management Plan* are included in **Appendix 7B**; the noted SOPs are included in **Appendix 7C**.

10.4 Hazardous Materials Management

Based on the current project design defined by (TetraTech, 2013), hazardous materials that will be consumed or used in mine construction, operations, and decommissioning/closure will typically include:

- No. 2 diesel/No. 4 fuel oil;
- gasoline, aviation fuel, and chainsaw fuel;
- lubricants, hydraulic fluid, and coolants;
- sodium cyanide and other chemical reagents;
- explosives;
- laboratory chemicals; and

- various paints, solvents, soaps, cleaners, insecticides, rodenticides, and herbicides.

Measures for the prevention or mitigation of environmental and social impacts from these sources are summarized in **Table 6.3-1**. The *social* impacts associated with these materials are related in large part to the mitigation of occupational health and safety concerns associated with their use and to their secure transport and storage in order to discourage theft, pilferage, uncontrolled use, and/or accidental spillage en route to the mine. These concerns are addressed primarily by the following documents:

- the “Labour Grievance Procedure” and “Community and Environmental Grievance Procedure” appended to the ESMS Plan (see **Appendix 7A**);
- the GGI *Occupational Health and Safety/Accident Prevention Plan, Emergency Preparedness and Response Plan, Transportation Management Plan, Community Relations Management Plan, and Influx Management Plan* (see **Appendix 7B**), as well as the *Cyanide Management Plan* and *Blasting Management Plan* that will be developed in advance of the operational phase of the Project; and
- several supporting SOPs (see **Appendix 7C**) as cited in governing management plans, including GG-14, “Handling and Storage of Hazardous Materials” and GG-24, “Recognition and Reporting of Safety Hazards.”

Associated measures for the prevention or mitigation of potential *environmental* impacts are generally described for each material category noted above, as follows:

- **Diesel and No. 4 fuel;** the current project design defined by (TetraTech, 2013) calls for the use of No 2 diesel fuel as the primary fuel to be used for all mobile and stationary equipment less the primary generator sets, which will be designed to operate on No. 4 fuel. No. 4 fuel is a blend of No. 2 diesel and No. 6 Heavy Fuel Oil (HFO). Additional tradeoff studies are being contemplated for several other power generation alternatives (see Sections 3.0 and 9.3). Although modular double-walled fuel tanks will be used to support construction activities, it is anticipated that large-volume single-wall tanks will be constructed to American Petroleum Institute (API) or other comparable standards. These tanks will store approximately 400,000 Liters (L) of No. 2 and No. 6 fuel and gasoline at a dedicated fuelling facility and ready line near the area of the open pits at the Aurora site. The facility will be lighted to support 24-hour operations and provided with appropriate fire suppression systems. Substantial additional tankage will be provided at Buckhall as previously noted (approximately 1,188,000 L diesel and 2,000,000 L No. 4 fuel). All tanks so constructed will be provided with concrete or high-density polyethylene- (HDPE) lined earthen berm secondary containments, oily water separators, and a variety of spill prevention and spill management measures; see the draft *Hazardous Materials Management Plan*; the *Buckhall Spill Contingency Plan*; and the *Spill Prevention, Control, and Contingency Plan (Aurora Project Areas)*, as well as SOP GG-14, “Handling and Storage of Hazardous Materials”, GG-17, “Vehicle Fuelling and Spill Prevention”, and other SOPs as cited. Full copies of the referenced

management plans are include for information in **Appendix 7B**; SOPs are compiled in **Appendix 7C**.

- **Lubricants, coolant, and other fuels;** lubricants, engine coolant, and other fuels (e.g., aviation fuel and premixed chainsaw fuel) will be kept at the Aurora and/or Buckhall sites, as noted in the *Hazardous Materials Management Plan*. These materials will normally be stored in barrels or metal or plastic jerrycans, in intermodal shipping containers that have been modified to provide reliable secondary containment (i.e., have had a steel containment barrier welded across the inside of the bottom of the container doors) or other specially constructed buildings with secondary containment (e.g., warehouses, or the dedicated aviation fuel storage sheds described in SOP GG-41, “Management of Aviation Fuel and Fuelling Operations”; see **Appendix 7C**).
- **Sodium cyanide and other chemical reagents;** as noted in Sections 9.3 and 10.3, cyanide will be delivered as dry briquettes in dedicated welded heavy-wall intermodal stainless steel ISO transportation/mixing tanks. As will be noted in the *Cyanide Management Plan* to be developed, prior to the operational phase of the Project, cyanide will be mixed to an approximately 28% solution by introducing plant makeup water (buffered with sodium hydroxide to a nominal pH 11 to preclude the potential for generation of HCN gas) to the as-delivered ISO tanks and circulating the water until the briquettes have completely dissolved. When mixed, contents will be transferred to stationary storage tanks with concrete secondary containments using a plant-side transfer pump. Empty delivery tanks will be inspected and returned to the cyanide supplier for reuse.

Other bulk reagents will be offloaded and stored in designated warehouse locations in accordance with the *Hazardous Materials Management Plan*; GG-14, “Handling and Storage of Hazardous Materials”; GG-15, “Forklift Safety”; and other SOPs as cited therein. These reagents will be delivered to the site by truck, typically in steel intermodal containers and in the following delivery forms:

- lime – dry powder, 20-tonne bulk containers;
 - activated carbon – dry granules, 500-kilogram (kg) nylon bulk bags;
 - sodium metabisulphite – dry granules, 1,000-kg nylon bulk bags;
 - copper sulphate – dry granules, 1,000-kg nylon bulk bags;
 - sodium hydroxide – dry granules, 1,000-kg nylon bulk bags;
 - nitric acid – 1000-L bulk plastic containers;
 - flocculent – dry powder, delivery containers to be determined (TBD); and
 - sodium borate, silica flour, soda ash, and potassium nitrate fluxes for the gold room; dry powder, 25-kg bags (palletized).
- **Explosives;** all blasting operations will be conducted in strict compliance with the Project *Blasting Management Plan*, to be developed and issued in accordance with

ESMS Plan requirements prior to the first delivery of explosives to the site late in the construction phase. Blasting agents will be delivered in separate loads by separate vehicles, as noted in the *Transportation Management Plan*. Open pit and underground blasting will be conducted using ANFO as a primary explosive, with emulsion as a secondary explosive in wet drillhole conditions. ANFO and emulsion will be stored in separate aboveground silos within the security perimeter of the Aurora site, with separate magazines provided for storage of detonators/initiators. Magazines and silos will be constructed in compliance with Guyanese law, GIIPs, and the conditions of the governing explosives transport, storage, handling, and usage permit.

- **Laboratory chemicals;** it is expected that GGI will maintain an assay and process control laboratory at the site that will be equipped with small quantities of standard laboratory reagents and chemicals as necessary to support required analytical processes. Such chemicals will typically be delivered to the Aurora site inside steel intermodal containers and will be kept in secure metal containment lockers under the direct control of the laboratory supervisors and technicians.
- **Paints, solvents, cleaners, insecticides, rodenticides, and herbicides;** small quantities of paints, solvents, cleaners, insecticides, rodenticides, and herbicides will be retained on site to support routine site maintenance, vector control, and malaria suppression program activities and will typically be transported to the Buckhall and/or Aurora site by truck in steel intermodal containers. These items will be kept in controlled warehouse locations in accordance with the *Hazardous Materials Management Plan*, with the exception that malaria suppression program supplies will be managed by responsible medical staff.

10.5 Adverse Community Health and Safety Risk in Provisioning and Regulating (Ecosystem) Services

As noted in Section 12, PS 6 considers two types of ecosystem services:

- Type I: Provisioning, regulating, cultural and supporting ecosystem services, over which the project proponent has direct management control or significant influence, and where impacts on such services may adversely affect communities; and
- Type II: Provisioning, regulating, cultural and supporting ecosystem services, over which the project proponent has direct management control or significant influence, and on which the project directly depends for its operations.

There are no human communities in reasonable proximity to the Aurora site that would be adversely affected by the Project's potential impacts on ecosystem services. At Buckhall, GGI's site relies entirely on rainwater collection or bottled water for potable uses. Potable water in the adjacent Buckhall community is also from rainwater collection or bottled sources, but there is no source connection with the GGI operation. No groups have identified any unique cultural services associated with either the Buckhall or Aurora areas. For these reasons, no Type I ecosystem services are identified.

The only Type II ecosystem service upon which GGI might be considered to depend is the provisioning of water for industrial uses at the Aurora site and for firefighting uses at GGI's Buckhall site. However, GGI has no direct management control over or significant influence on the provisioning of water at either location. At Buckhall, firefighting water will be pumped from the Essequibo River on an as-needed basis. At the Aurora site, there will be no direct abstraction of water from the Cuyuni River. Per Section 18.2.3 of TetraTech (2013), at the Aurora site, raw water for industrial purposes will be obtained from water wells drilled into the underlying bedrock, collection of surface water from creeks, and rain water harvesting systems; potable water will be obtained from rain water harvesting systems. During the operational phase of the Project, water will be recycled for industrial purposes to minimize fresh water extraction needs and will be temporarily retained and diluted to manage sedimentation and overall effluent quality within the guidelines established by the IFC "Environmental, Health, and Safety Guidelines for Mining" (IFC, 2007b), Table 1. However, as noted in Section 20.2 of TetraTech (2013), the net water balance for the project is expected to be significantly positive, and the Project design will assume that excess water will be continuously discharged to the environment.

10.6 Community Exposure to Disease

Protection of the health of the GGI workforce, including contractors and visitors, is considered to be a vital factor in the success of the Project. Prevention of the transmission of disease between the GGI workforce and the affected communities is also a key consideration. Exposure to disease will be managed primarily by restricting GGI workforce, contractor, and visitor interactions with the residents of Aranka Mouth and Buckhall, as well as interactions with transient groups or individuals engaged in ASM or other intrusive activities on or near the Project concession. All GGI workers, contractors, and visitors will be subject to screening for communicable diseases in accordance with SOP GG-10, "Prevention and Monitoring of Communicable Diseases," prior to travelling to the Aurora site. Workers will be trained in the requirements of GG-10 in accordance with Section 5.2 of the *ESMS Plan* (see **Appendix 7A**). GG-10 reinforces relevant aspects of the Code of Conduct in the GGI Labour Grievance Procedure, that is:

- strict prohibitions on the use of alcohol and illicit drugs,
- proper procedures for waste segregation and disposal,
- minimization of interactions with residents of affected communities, and
- prohibitions on the harboring of wild animals or plants.

GG-10 also establishes basic requirements for personal hygiene, food preparation and handling, and recognition of the symptoms of communicable diseases. It also provides guidance on the provision of emergency medical care to affected community residents or transient groups or individuals, and specific emergency actions to take place in the event of a suspected disease outbreak.

As noted in 10.2, the community of Buckhall is expected to be impacted by Project activities on nearly a daily basis, and it will be especially important to manage workforce interactions with

community residents. Direct interactions between GGI personnel and contractors and the local community will be restricted to employees or contractors whose families may live in or near Buckhall or to those personnel authorized to organize or conduct periodic formal community relations contacts in accordance with the Project's *Community Relations Management Plan* and *Influx Management Plan*. Interactions with the community will be limited to certain types of legal commerce. Any community interactions involving GGI workers and the sex trade will be considered breach of both proper conduct and safety regulations under the GGI Labour Grievance Procedure and *Community Relations Management Plan* and will not be permitted. Purchase or sale of alcohol or illicit drugs by GGI or contractor employees will likewise be considered a behavioral and security breach and will be treated as grounds for immediate dismissal.

GGI's current Environmental Permit (Guyana EPA, 2010) also requires periodic health awareness campaigns for the workforce as well as the affected communities, with particular emphasis on the prevention and control of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), other sexually transmitted diseases (STDs), and other potential endemic diseases (e.g., malaria, dengue). Workforce training will be managed as described in GG-10 and the *Occupational Health and Safety/Accident Prevention Plan*. Health awareness campaigns to the affected communities (Aranka Mouth and Buckhall) will be organized and conducted in compliance with the *Community Relations Management Plan* and GG-35, "Community Health and Safety Awareness Meetings." See **Appendices 7B and 7C**.

10.7 Emergency Preparedness and Response

As an element of GGI ESMS, GGI has developed an *Emergency Preparedness and Response Plan* (see **Section 7B**) that is designed to operate in conjunction with the *Occupational Health and Safety/Accident Prevention Plan*, *Cyanide Management Plan*, and other specific management plans, with the intention of minimizing the potential for accidents and other emergency situations involving mine construction activities as well as the Project's built structures (e.g., mine, mill, leach facility, TMA, MWP, FWP) in operation or decommissioning/closure.

The *Emergency Preparedness and Response Plan* addresses the minimum geotechnical safety requirements of (IFC, 2007), as well as GIIPs drawn from *APELL for Mining: Guidance for the Mining Industry in Raising Awareness and Preparedness for Emergencies at Local Level* (UNEP, 2001), the ICMC (ICMI, 2009) and other sources. The *Emergency Preparedness and Response Plan* also governs the performance of periodic cyanide usage/transportation emergency drills, including the engagement of Barama personnel and local authorities in spill control and cleanup actions, as well as the interactions between GGI security personnel and the nearest Guyana Police Force and Guyana Defence Force outposts in the event that additional security resources may be needed in response to particular criminal or security emergencies [e.g., serious crimes; potential incursions of armed groups (foreign or domestic); political turmoil; illegal smuggling, trafficking, or other criminal activities].

In keeping with the requirements of the Project's current Environmental Permit (Guyana EPA, 2010), the plan also includes:

- specific Guyana Geology and Mines Commission (GGMC) and Guyana EPA reporting requirements associated with any environmental emergencies, releases of contaminants, pollution incidents, or any observations of illegal wildlife trapping or trading;
- at the Aurora site, a defined flood alarm level for the Cuyuni requiring evacuation of the mine pits and/or underground operations; and
- at the Buckhall site, a defined flood alarm level for the Essequibo River requiring site evacuation.

Emergency Preparedness and Response Plan Requirements will be periodically summarized and communicated to the Aranka Mouth and Buckhall communities via the communication mechanisms describe in the *Community Relations Management Plan* and *Cyanide Management Plan*.

10.8 Security Services

GGI will not directly engage Republic of Guyana military or police resources for providing routine security services for the Project. GGI has maintained its own security service in Guyana over 10 years, and GGI security personnel have very substantial experience in the management of interactions with individuals or groups involved in ASM or other legal or illegal intrusive human activities in and around the Project concession. It should be noted that GGI's current Chief of Security formerly provided personal security services to Guyana's current Prime Minister, Samuel Hinds, and has served in difficult United Nations (UN) peacekeeping missions in both El Salvador and Rwanda. GGI's security service maintains liaison contacts with the nearest Guyana Police Force and Guyana Defense Force outposts in the event that additional security resources may be needed in response to evidence of significant crimes, criminal activities, or other security issues. GGI's site security practices are summarized in SOP GG-40, "Site Security" (see **Appendix 7C**), and are generally consistent with the practices outlined in the UN "Code of Conduct for Law Enforcement Officials" (UN, 1990 and the UN "Basic Principles on the Use of Force and Firearms by Law Enforcement Officials" (UN, 1979). Specific security actions to be taken in the event of site emergencies are also described in the *Emergency Preparedness and Response Plan* prepared for the Project (see Section 10.7 and **Appendix 7B**).

Grievance mechanisms have also been established that are available to all external stakeholders and the GGI workforce that are designed to facilitate the evaluation and prompt resolution of any potential concerns with respect to the performance or behavior of GGI's security personnel. These mechanisms are documented in two procedures: "Labour Grievance Procedure" and "Community and Environmental Grievance Procedure," full texts of which are appended to the Project's *ESMS Plan* (see **Appendix 7A**).

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Section 11:
Land Acquisition and Involuntary Resettlement (Ref: IFC PS 5)

Contents

	Page
11 Land Acquisition and Involuntary Resettlement (Ref: IFC PS 5)	11-2
11.1 Summary of PS 5 Requirements	11-2
11.2 Applicability of PS 5 to the Project	11-2
11.3 Displacement Potential in Project Design	11-4
11.4 Compensation and Benefits for Displaced Persons	11-4
11.5 Community/Stakeholder Engagement	11-5
11.6 Grievance Mechanisms	11-5
11.7 Resettlement and Livelihood Restoration Considerations	11-5

List of Figures

Figure 11.2-1: Project Concession (A1 Mining License) Boundary in Relation to Environmental AOI

11 Land Acquisition and Involuntary Resettlement (Ref: IFC PS 5)

11.1 Summary of PS 5 Requirements

Performance Standard (PS) 5 recognizes that project-related land acquisition and restrictions on land use can adversely impact prior use persons and communities. PS 5 applies to physical and/or economic displacement resulting from a number of different types of land-related transactions, including:

- land rights or land use rights acquired through expropriation or other compulsory procedures in accordance with the legal system of the host country;
- land rights or land use rights acquired through negotiated settlements with property owners or those with legal rights to the land if failure to reach settlement would have resulted in expropriation or other compulsory procedures;
- project situations where involuntary restrictions on land use and access to natural resources cause a community or groups within a community to lose access to resource usage where they have traditional or recognizable usage rights;
- certain project situations requiring evictions of people occupying land without formal, traditional, or recognizable usage rights; or
- restrictions on access to land or use of other resources including communal property and natural resources such as marine and aquatic resources, timber and non-timber forest products, freshwater, medicinal plants, hunting and gathering grounds and grazing and cropping areas.

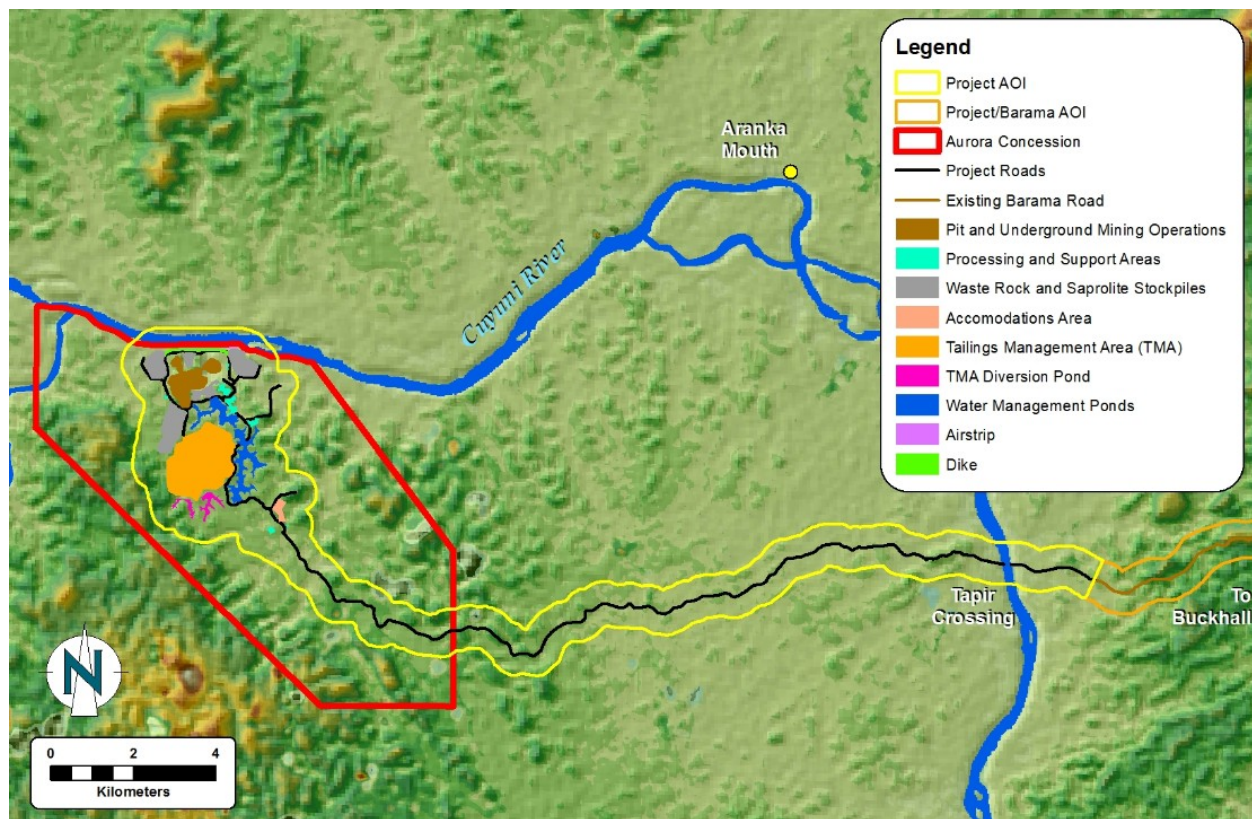
PS 5 does not apply to resettlement resulting from *voluntary* land transactions (i.e., market transactions in which the seller is not obliged to sell and the buyer cannot resort to expropriation or other compulsory procedures sanctioned by the legal system of the host country if negotiations were to fail).

11.2 Applicability of PS 5 to the Project

There are currently no permanent communities or residences within the boundaries of the Aurora Gold Project (Project) concession (see **Figure 11.2-1**) or the project's environmental or social areas of influence (see Sections 4.1 and 5.4) that would require any physical displacement or resettlement actions. For this reason, PS 5 is not considered to be applicable to the Project. The Project concession is defined as the area within GGI's A1 Mining Permit boundary.

As noted in ERM (2010), mineralized zones were first discovered at the Aurora mine site during the Pigeon Island gold rush of 1911. Since that time, the property has been owned, explored, and exploited by several entities. In 1998, Guyana Goldfields acquired a 100% option on the

Figure 11.2-1: Project Concession (A1 Mining License) Boundary in Relation to Environmental AOI



Aurora concession property from the previous owner, who had acquired the property in 1995; this purchase may be characterized as a “willing buyer – willing seller” arrangement. GGI acquired a prospecting permit in 2004, which was replaced by a Mining License (ML; a.k.a. the “A1” license) in November 2011, which covers 5,802 hectares (ha) and gives the company exclusive rights to build and operate the mine. In addition to the A1 license, Guyana Goldfields holds 10 prospecting licenses that are contiguous with the A1 license. The total combined area of all these licenses is approximately 38,900 ha.

Access to the land for the Buckhall river port and logistics center was obtained under a 50-year-long renewable lease with the Guyana Lands and Surveys Commission (GLSC) and did not require the displacement of any residents, businesses, or any other prior uses of the land by the adjacent village. Land access and usage for the construction of the road extension from the Barama Road to Tapir Crossing, ferry docking facilities at Tapir Crossing, and the road from Tapir Crossing to the Aurora site was granted by permit from the Guyana Ministry of Transportation (GMOT).

As noted in Section 4.2 and Appendix A of TetraTech (2013), in March 2012, GGI commissioned an independent legal review of the mineral tenure and surface rights of the Project as well as site access and permitting issues. The results of the review confirmed that all of these Project aspects were in good standing.

11.3 Displacement Potential in Project Design

GGI owns 100% of the Project, as defined by its A1 ML boundary as depicted in **Figure 11.2-1**. The A1 license grants the company full and exclusive surface and subsurface rights and permission to build and operate the mine. No physical or economic displacement was involved in the purchase of the Project. The full scope and life-cycle of anticipated mining activities are described in Section 2 and TetraTech (2013) and will be conducted within the A1 boundary. Assuming that illegal activities are not involved, there is therefore no potential for economic or physical displacement of any affected communities or persons, as defined by PS 5, over the life of the Project.

It may be noted that the area of the Project will be removed as a potential economic resource to persons involved in informal or illegal artisanal and small-scale mining (ASM) activities. However, no existing ASM operations were displaced, legal or illegal, in the establishment of the A1 ML. Furthermore, GGI's actions in establishing its license have been independently confirmed to be in full conformity with the laws of the Republic of Guyana. GGI's current Environmental Permit (Guyana EPA, 2010) also specifically requires that GGI systematically discourage influx to the Project area, in order to prevent or minimize the potential environmental, health and safety, and other social impacts that might be associated with such influx. However, if transient groups or individuals engaged in ASM believe that they are being unfairly restricted with respect to traditionally unhampered accessibility to mineral resources, engagement and grievance mechanisms are provided via the *Project Community Relations and Communication Plan*, *Influx Management Plan*, and the Community and Environmental Grievance Procedure appended to the Project *ESMS Plan* (see **Appendices 7A and 7B**).

As previously stated, GGI's Buckhall property was obtained under a 50-year-long renewable lease with the GLSC and did not require displacement or loss of use impacts on residents of the adjacent village. Land access for the construction of the extension of the Barama Road to Tapir Crossing and on to the Aurora site was granted by the GMOT permit. Full ownership of the airstrip, the road between the Aurora site and the Barama Road, the ferry landings at Tapir Crossing, and the Buckhall Port and logistics center is expected to revert to the Government of Guyana at the end of mine life (TetraTech, 2013).

11.4 Compensation and Benefits for Displaced Persons

There are no displaced persons, as defined by PS 5, who would need to be considered with respect to compensation or other special benefits. GGI acquired its ownership interest in the Project in accordance with a sales agreement dated May 20, 1998 between GGI and Mr. Alfro Alphonso, the previous owner. By the terms of that agreement, GGI agreed to make annual advance royalty payments to Mr. Alphonso in the aggregate of US\$225,000 per year during the three-year period following the commencement of commercial production and to pay an additional 2% net smelter royalty to Mr. Alphonso thereafter. On March 18, 2004, the original agreement was amended, pursuant to which GGI agreed to pay Mr. Alphonso an annual fee of US\$100,000 for as long as Guyana Goldfields maintains an interest in the Project, up to a maximum of US\$1,500,000, in lieu of the advance and net smelter royalty payments described by the original agreement.

The ML, obtained in November 2011, gives the company exclusive rights to build and operate the mine. At the same time, the company signed a Mineral Agreement (MA) with the Government of Guyana and the Guyana Geology and Mines Commission (GGMC) which sets the fiscal regime, taxation, and royalties as they affect the operation of the mine. The ML and the MA were signed by the company's wholly owned subsidiary in Guyana (AGM, Inc.) and are valid for 20 years and renewable on application for additional 7 year periods for as long as mining operations continue on the property (SRK, 2012).

11.5 Community/Stakeholder Engagement

The Project will not cause physical or economic displacement, and as a consequence, community and/or stakeholder engagement specifically focused on these aspects is not required. The grievance mechanisms noted in Section 11.6 are nevertheless available to individual stakeholders for redress or resolution of any specific complaints or concerns.

11.6 Grievance Mechanisms

Since the Project will not cause physical or economic displacement to affected communities or to individuals engaged in legal activities, a grievance mechanism specifically focused on these aspects is not required. As previously noted, if transient groups or individuals engaged in ASM believe that they are being unfairly denied traditional access to mineral resources, engagement and grievance mechanisms are provided pursuant to PS 1 requirements, via the Project *Community Relations and Communication Plan*, *Influx Management Plan*, and the Community and Environmental Grievance Procedure appended to the Project *ESMS Plan* (see **Appendices 7A and 7B**).

11.7 Resettlement and Livelihood Restoration Considerations

As there are no affected communities within the Project concession, and as GGI's Buckhall operation is constrained with respect to GGI's obligations to prevent, discourage, or minimize influx, no considerations for resettlement or livelihood restoration within the adjacent community was deemed applicable. The grievance mechanisms noted in Section 11.6 are nevertheless available to individual stakeholders for redress or resolution of any complaints or concerns with respect to resettlement and livelihood restoration.

References

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Section 12:
Biodiversity Conservation and Sustainable
Natural Resource Management (Ref: IFC PS 6)

Contents

	Page
12 Biodiversity Conservation and Sustainable Natural Resource Management (Ref: IFC PS 6)	12-2
12.1 Summary of PS 6 Requirements	12-2
12.2 Protection and Conservation of Biodiversity	12-3
12.2.1 Modified Habitat	12-3
12.2.2 Natural Habitat	12-3
12.2.3 Critical Habitat	12-4
12.3 Invasive Alien Species	12-4
12.4 Management of Ecosystem Services	12-5
12.5 Sustainable Management of Living Natural Resources	12-6
12.6 Supply Chain Considerations	12-6

12 Biodiversity Conservation and Sustainable Natural Resource Management (Ref: IFC PS 6)

12.1 Summary of PS 6 Requirements

International Finance Corporation (IFC) Performance Standard 6 (PS 6) recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to the overall concept of sustainable development. The requirements of this PS are expressed during the environmental and social risks and impact assessment process and are applied to 1) projects located in modified, natural, and critical habitats; 2) projects that potentially impact or are dependent on ecosystem services over which the project sponsor has direct management control or significant influence; or 3) projects that include the production of living natural resources.

The general requirements of PS 6 can be summarized as follows:

- the risks and impacts identification process should consider direct and indirect impacts on biodiversity and ecosystem services and identify and significant residual impacts;
- the project should seek to avoid impacts and, where not possible, to minimize impacts and restore biodiversity and ecosystems services, adopting a practice of adaptive management that responds to the changing conditions and results of monitoring throughout the project's lifecycle;
- for projects in natural habitats, the project sponsor must retain competent professionals to assist in conducting the risks and impacts identification process; and
- for projects in critical habitats, the project sponsor should retain external experts with appropriate regional experience to assist in the development of a mitigation hierarchy that complies with PS 6 and to verify the implementation of those measures.

Because the Aurora Gold Project (Project) is located in modified or natural habitat areas and potentially impacts ecosystems services, certain aspects of PS 6 are applicable. GGI has therefore addressed the general requirements of PS 6 by engaging competent professionals and biodiversity specialists to perform baseline studies of the biodiversity of the Project's area of influence (see Section 4), to develop the Environmental and Social Impact Assessment (ESIA) embodied in this document to meet the requirements of PS 1 through PS 8, and to develop appropriate management and monitoring plans to address the impacts so identified (see Section 7 and **Appendices 7A, 7B, and 7C**).

Section 6 of this ESIA presents the overall methodology and outcomes of the risks and impacts identification process, including direct, indirect, cumulative, and residual impacts. Table 6.3-1 includes the mitigation measures established for the significant risks and impacts associated with biodiversity and ecosystem services. With respect to biodiversity and ecosystem services, the general approach to the development of the mitigation measures outlined in Table 6.3-1 applies the following mitigation hierarchy:

- **avoidance** of impacts, wherever possible;
- **minimization** of impacts, where avoidance cannot be practically achieved;
- **restoration** measures, where possible; and
- the establishment of **biodiversity offsets**, where full restoration of certain Project areas (e.g., the mined-out pits or the airstrip and access roadways required to be turned over to the Government of Guyana on closure) is not possible.

12.2 Protection and Conservation of Biodiversity

For the purposes of implementing PS 6, the IFC recognizes three categories of habitats: modified, natural, and critical. Critical habitats are typically considered to be a subset of modified or natural habitats. The mitigation hierarchy for the protection and conservation of biodiversity includes biodiversity offsets to achieve “no net loss” of natural habitats.

12.2.1 Modified Habitat

PS 6 applies to modified habitats that have significant biodiversity value. In these situations, the project proponent is expected to minimize impacts on such biodiversity and implement mitigation measures as appropriate.

Within the Aurora concession, many habitat areas have been modified by the historic exploration activities that have been conducted since the 1930s. Outside of the Aurora concession, much habitat (especially riparian and aquatic habitat) has been modified by artisanal and small-scale mining (ASM) activities that date back over 100 years.

To the extent practicable, the Project has reused existing modified habitats (e.g., current airstrip and mancamp areas, laydown areas, access roads, and drillpad areas from historical subsurface explorations) for the siting of new facilities and proposed mining activities, avoiding and minimizing use of natural habitats wherever possible.

12.2.2 Natural Habitat

Natural habitats are defined as those habitats that are composed of viable assemblages of species of largely native origin and/or where human activity has not essentially modified an area’s primary ecological functions and species composition. PS 6 requires that projects in natural habitats implement mitigation measures designed to achieve “no net loss” wherever feasible.

PS 6 defines “no net loss” as “the point at which project-related impacts on biodiversity are balanced by measures taken to avoid and minimize the project’s impacts, to undertake on-site restoration and finally to offset significant residual impacts, if any, on an appropriate geographic scale (i.e., local, landscape-level, national, regional).” In order to achieve this “no net loss” goal, where feasible, the Project will promote the restoration of basic ecological processes in areas of existing degraded habitat (i.e., restore and, where appropriate, revegetate land areas impacted by historical ASM or other intrusive human activities) within the Aurora concession, in addition to the progressive rehabilitation of lands affected by the Project (e.g., progressive reclamation of waste rock stockpiles using native species in accordance with the *Project Mine Reclamation*

and Closure Plan; continual monitoring for erosion and control of erosion and sedimentation via revegetation with native species and construction of sediment control structures in accordance with the *Erosion Prevention and Control Plan*).

The Project has also been optimized through an iterative design process to minimize land conversion and the overall area of the Project footprint. For example, preliminary project maps prepared by AMEC in 2010 [which are reflected in the project design presented in the April 2012 National Instrument (NI) 43-101 Technical Report (SRK, 2012) indicated that the Project footprint would occupy an area of approximately 2,000 hectares (ha). The current project design documented in the January 2013 NI 43-101 (TetraTech, 2013) presents an overall project footprint that has been reduced to approximately 1,200 ha (see Section 3 and Table 3-1 for additional discussion).

12.2.3 Critical Habitat

Critical habitats are defined as areas with high biodiversity value, including (1) habitat of significant importance to Critically Endangered and/or Endangered species; (2) habitat of significant importance to endemic and/or restricted-range species; (3) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (4) highly threatened and/or unique ecosystems; and/or (5) areas associated with key evolutionary processes.

Section 4.1.14 of this ESIA provides a detailed assessment of the criteria for critical habitat and concludes that the Project area of influence (AOI) does not qualify as critical habitat given that none of the five criteria noted in the preceding paragraph apply. However, the IFC's Guidance Note for PS 6 states that the determination of critical habitat is not necessarily limited to these criteria and that "other recognized biodiversity values might also support a critical habitat designation." In particular, the Guidance Note (i.e., Paragraph 56) mentions as examples "areas of primary/old-growth/pristine forests and/or other areas with especially high levels of species diversity" and "areas of high scientific value such as those containing concentrations of species new and/or little known to science." As discussed in the preamble to Section 4, the Project AOI and the Cuyuni basin in general have been subject to considerable intrusive human activity since the 19th century, including ASM activities, timber harvesting, and hunting. The Project AOI generally cannot be considered as an "area of primary/old-growth/pristine forests." The biodiversity surveys discussed in Section 4 and associated literature reviews also do not support the characterization of Project AOI as one "with especially high levels of species diversity" or one of "high scientific value such as those containing concentrations of species new and/or little known to science." Conservation and protected areas prioritizations for Guyana indicate that other areas, such as the isolated mountains of the Guiana Shield highlands, the Rupununi Savannas, or the forests of southern Guyana, to be of far higher biodiversity and scientific value than the northern lowland areas.

12.3 Invasive Alien Species

PS 6 prohibits IFC clients from intentionally introducing any new alien species unless it is done in accordance with the applicable host country regulatory framework, and furthermore absolutely prohibits any introduction of any alien species with a high risk of invasive behavior. In keeping with this injunction, GGI does not plan to use any alien plant species not already

present for revegetation, landscaping, or any other purpose; small controlled vegetable gardens may be permitted at the man-camp in the operational phase of the project but will be eliminated in closure. The keeping of domestic animals (e.g., pigs, cattle) at the project site will be expressly forbidden. Also, PS 6 requires IFC clients to exercise diligence in not spreading alien species already present and to, as practicable, take measures to eradicate such species in areas where they have management control. The biodiversity surveys discussed in Section 4 did not show any significant presence of invasive alien species that merit any such control or eradication efforts.

12.4 Management of Ecosystem Services

PS 6 defines ecosystem services as “the benefits that people, including businesses, obtain from ecosystems” and organizes these services into four major categories:

- *Provisioning ecosystem services*, such as (i) agricultural products, seafood and game, wild foods, and ethnobotanical plants; (ii) water for drinking, irrigation, and industrial purposes; (iii) forest areas which provide the basis for many biopharmaceuticals, construction materials, and biomass for renewable energy.
- *Regulating ecosystem services*, such as (i) climate regulation and carbon storage and sequestration; (ii) waste decomposition and detoxification; (iii) purification of water and air; (iv) control of pests, disease and pollination; (v) natural hazard mitigation.
- *Cultural services*, such as (i) spiritual and sacred sites; (ii) recreational purposes such as sport, hunting, fishing, or ecotourism; (iii) scientific exploration and education.
- *Supporting services*, which refer to the natural processes that maintain the other services such as (i) nutrient capture and recycling; (ii) primary production; (iii) pathways for genetic exchange.

Paragraph GN128 of the PS 6 Guidance Notes (IFC, 2012a) states that “ecosystem services are indeed services because there is an identified (human) beneficiary (i.e., the user)” and that “until there is a person or group benefitting from [a] process, it is not a service.” It further notes that the beneficiary might be on the local, regional, or global scale.

For the purposes of PS 6 implementation, ecosystem services are categorized as two types:

- Type I: Provisioning, regulating, cultural and supporting ecosystem services, over which the project proponent has direct management control or significant influence, and where impacts on such services may adversely affect communities; and
- Type II: Provisioning, regulating, cultural and supporting ecosystem services, over which the project proponent has direct management control or significant influence, and on which the project directly depends for its operations.

There are no human communities in reasonable proximity to the Aurora site that would be adversely affected by the Project’s potential impacts on ecosystem services. At Buckhall, GGI’s site relies entirely on rainwater collection or bottled water for potable uses. Potable water in the

adjacent Buckhall community is also from rainwater collection or bottled sources, but there is no source connection with the GGI operation. No groups have identified any unique cultural services associated with either the Buckhall or Aurora areas. For these reasons, no Type I ecosystem services are identified.

The only Type II ecosystem service upon which GGI might be considered to depend is the provisioning of water for industrial uses at the Aurora site, and for firefighting uses at GGI's Buckhall site. However, GGI has no direct management control over or significant influence on the provisioning of water at either location. At Buckhall, firefighting water will be pumped from the Essequibo River on an as-needed basis. At the Aurora site, there will be no direct abstraction of water from the Cuyuni River. Per Section 18.2.3 of TetraTech (2013), at the Aurora site, raw water for industrial purposes will be obtained from water wells drilled into the underlying bedrock, collection of surface water from creeks, and rain water harvesting systems; potable water will be obtained from rain water harvesting systems. During the operational phase of the project, water will be recycled for industrial purposes to minimize fresh water extraction needs and will be temporarily retained and diluted to manage sedimentation and overall effluent quality within the guidelines established by the IFC "Environmental, Health, and Safety Guidelines for Mining" (IFC, 2007b), Table 1. However, as noted in Section 20.2 of (TetraTech, 2013) the net water balance for the project is expected to be significantly positive, and the Project design will assume that excess water will be continuously discharged to the environment.

With respect to potential impacts on the Cuyuni River, given its very large drainage area [approximately 53,500 km² (AMEC, 2009)] and the very substantial (>2 meters) average annual rainfall in the Cuyuni basin, the Project's likely effect on Cuyuni River flow rates is insignificant.

12.5 Sustainable Management of Living Natural Resources

These requirements apply only to IFC clients engaged in the primary production of living natural resources such as natural and plantation forestry, agriculture, aquaculture, and fish. As such, these requirements are considered to not be applicable to the Project.

12.6 Supply Chain Considerations

These requirements apply only to IFC clients engaged in purchase of primary production (here meaning the products of living natural resources) that is known to be produced in regions where there is a risk of significant conversion of natural and/or critical habitats. These requirements are therefore not applicable to the Project.

References

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Section 13:
Indigenous Peoples
(Ref: IFC PS 7)

Contents

	Page
13 Indigenous Peoples (Ref: IFC PS 7)	13-2
13.1 Summary of PS 7 Requirements	13-2
13.2 Applicability of PS 7 to the Aurora Gold Project	13-2
13.3 Other Considerations Involving Indigenous Peoples	13-5

Figures

- Figure 13.2-1: Map of Titled Amerindian Lands in the Region Surrounding the Project
Figure 13.2-2: Map of Titled Amerindian Lands in Guyana

13 Indigenous Peoples (Ref: IFC PS 7)

13.1 Summary of PS 7 Requirements

Performance Standard (PS) 7 (IFC, 2012) recognizes that indigenous peoples, as social groups with identities that are distinct from mainstream groups in national societies, are often among the most marginalized and vulnerable segments of the population. In many cases, their economic, social, and legal status limits their capacity to defend their rights to, and interests in, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development.

There is no universally accepted definition of “indigenous peoples.” In PS 7, the term is used in a generic sense to refer to a distinct social and cultural group possessing, in varying degrees, the following characteristics:

- *self-identification* as members of a distinct indigenous cultural group and recognition of this identity by others;
- *collective attachment to geographically distinct habitats or ancestral territories in the project area* and to the natural resources in these habitats and territories;
- *customary cultural, economic, social, or political institutions* that are separate from those of the mainstream society or culture; or
- *a distinct language or dialect*, often different from the official language or languages of the country or region in which they reside.

PS 7 therefore applies to communities or groups of indigenous peoples who maintain a collective attachment (i.e., whose identity as a group or community is linked) to distinct habitats or ancestral territories and the natural resources therein. PS 7 may also be interpreted to apply to communities or groups that have lost collective attachment to distinct habitats or ancestral territories in the project area, occurring within the concerned group members’ lifetime, because of forced severance, conflict, government resettlement programs, dispossession of their lands, natural disasters, or incorporation of such territories into an urban area.

13.2 Applicability of PS 7 to the Aurora Gold Project

PS 7 has been determined to be not applicable to the Aurora Gold Project (Project) since there are no affected communities of indigenous peoples (as defined by PS 7) in the Project’s direct area of influence (AOI). According to geographic data provided by the Guyana Lands and Survey Commission (see **Figures 13.2-1** and **13.2-2**), the Project is not located on or adjacent to any titled Amerindian lands. In addition, Amerindians do not use lands within the Project’s environmental AOI (see **Figure 4.1-1**) for seasonal or cyclical use, for their livelihoods, or for cultural, ceremonial, or for any spiritual purposes that may define their identity or community. As noted in **Figure 13.2-1**, the nearest Amerindian communities are Bethany (approximately 5 km northwest of Buckhall and north of the Barama Road), and Kurutuku, which is approximately 40 km west of the Aurora mine site, on the Cuyuni River. Although the residents of Kurutuku may occasionally use the Cuyuni River for transportation purposes, the Project is not expected to adversely impact river navigation on the Cuyuni, and it is understood that Kurutuku residents

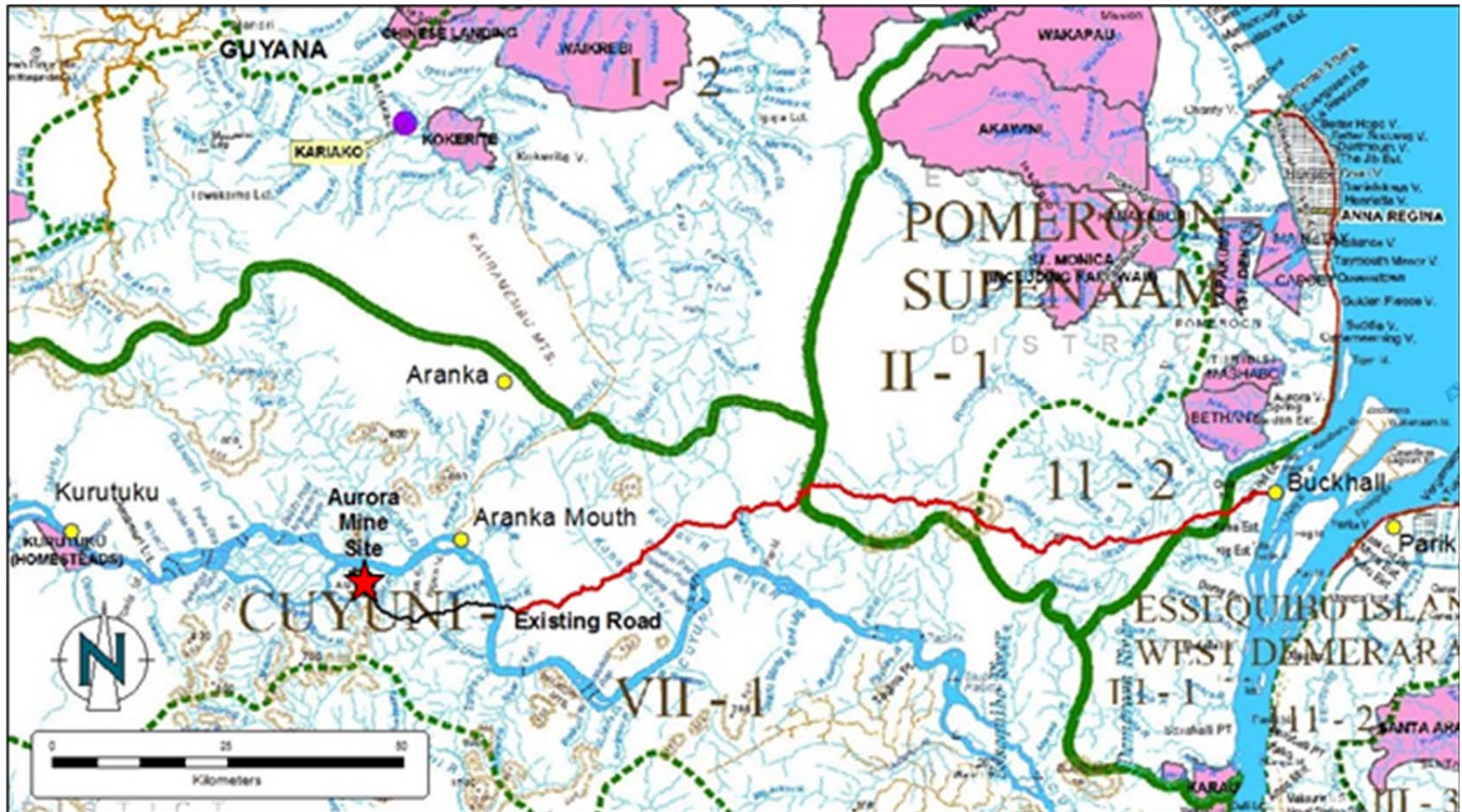


Figure 13.2-1: Map of Titled Amerindian Lands in the Region Surrounding the Project

(Note: excerpted from Figure 13.2-2. Titled land areas are shown in pink; the existing Barama Road is marked in red, and the road extension constructed to Tapir Crossing and the Aurora mine site is shown in black.)

Figure 13.2-2: Map of Titled Amerindian Lands in Guyana
(Source: Guyana Lands and Survey Commission, Land Information and Mapping Division, 2005)

often prefer to go upstream to Venezuela for provisions rather than downstream to the Essequibo River due to the rapids at Devil's Hole (between Kurutuku and the Aurora site), which are especially dangerous in low water (dry season) conditions. There are likewise no anticipated adverse impacts to the Amerindian residents of Bethany. GGI's Buckhall logistics facility is secure and self-contained and is located 5 km south of Bethany, and the Barama Road (i.e., the main road between Buckhall and the Aurora site) route extends immediately west from Buckhall and does not pass through Bethany. It should also be noted that the specific constraints on interactions by the GGI and contractor workforce with the community of Buckhall described in Section 10.6 will also apply to other outlying villages in the Buckhall area.

13.3 Other Considerations Involving Indigenous Peoples

Although the requirements of PS 7 have been determined to be not applicable, GGI has undertaken an engagement process with communities of indigenous peoples in the region surrounding the Project as noted in Section 5. This engagement process has included stakeholder analysis and engagement planning, disclosure of information, consultation, and participation, in a culturally appropriate manner.

The Free, Prior, and Informed Consent (FPIC) requirements of PS 7 are likewise not applicable to the Project, because:

- there will be no adverse impacts on lands or natural resources subject to traditional ownership or under customary use by indigenous peoples;
- there will be no relocation of indigenous peoples from lands or natural resources subject to traditional ownership or under customary use; and
- the Project is not expected to significantly impact any critical cultural heritage [see **Appendix 14A**, "Technical Report Identifying the Potential Range of Cultural Resources within the Aurora Gold Mining Project Area, Guyana" (Plew, 2012)].

Similarly, because there are no affected communities of indigenous peoples, the Project is not required to formally collaborate with such communities to identify mitigation measures or opportunities for culturally appropriate and sustainable development benefits. The Project has nevertheless extended the benefits of the Project to indigenous peoples through its hiring practices. As part of community outreach activities dating back to 1996, GGI has hired workers from two Amerindian communities in the region: Saint Cuthbert's Mission and Maruca (see Section 5.5.4). These actions have had a positive impact on these two Amerindian communities, and it is expected, as the Project goes forward, other communities will ultimately be contacted with respect to potential employment opportunities. All such interactions will be managed from GGI's Georgetown offices in compliance with the Project's *Community Relations Management Plan* and *Influx Management Plan*, however, and workers will be subject to the same general code of conduct that applies to all GGI workers and contractors, as implied in the Project's Labour Grievance Procedure (included as part of the *ESMS Plan*; see **Appendix 7A**).

Lastly, although PS 7 has been determined not to apply to the Project, GGI will nevertheless maintain close contact and communications with appropriate agencies of the Republic of Guyana and other stakeholders who, among their other interests may also be concerned with the continued welfare of Amerindian communities, through the processes described in the Project's *Community Relations Management Plan* and *Influx Management Plan*.

References

IFC, 2012. IFC Performance Standards on Environmental and Social Sustainability. World Bank/International Finance Corporation, Washington, DC. January 1, 2012.

Section 14:
Cultural Heritage (Ref: IFC PS 8)

Contents

	Page
14 Cultural Heritage (Ref: IFC PS 8)	14-1
14.1 Description of Cultural Heritage Considerations in Area Affected by Project	14-1
14.2 Protective Measures for Cultural Artifacts	14-2

14 Cultural Heritage (Ref: IFC PS 8)

Performance Standard 8 (PS 8) recognizes the importance of cultural heritage for current and future generations, consistent with the “Convention Concerning the Protection of the World Cultural and Natural Heritage” (UNESCO, 1972) and standards set by the “Convention on Biological Diversity” (UNEP, 1992). PS 8 is focused on ensuring that project proponents protect cultural heritage in the course of their project activities. The general objectives of the PS are to:

- protect cultural heritage from the adverse impacts of project activities and support its preservation; and
- promote an equitable sharing of potential benefits from the use of cultural heritage.

Articles 1 and 2 of (UNESCO, 1972) define “cultural heritage” as:

- **monuments**, e.g., architectural works, monumental sculpture or painting, archaeological elements or elements or structures; inscriptions; cave dwellings, and or combinations thereof which may be considered to have “...outstanding universal value from the point of view of history, art or science”;
- **groups of buildings** which are of “...outstanding universal value from the point of view of history, art, or science because of their architecture, their homogeneity or their place in the landscape”; and
- **archaeological and/or natural sites** which have “...outstanding universal value from [an] historical, aesthetic, ethnological or anthropological” perspective.

The cultural heritage aspects of the Aurora Gold Project (Project) and the measures taken to identify and protect such aspects from potentially adverse project impacts are discussed in the following paragraphs.

14.1 Description of Cultural Heritage Considerations in Area Affected by Project

As previously noted, the Project site is in a remote, largely undeveloped, and heavily forested area of northwest Guyana. The Project’s area of influence (AOI) has been significantly impacted by artisanal and small-scale mining (ASM), logging, hunting, and other intrusive human activities for well over a hundred years. No historical monuments or groups of buildings exist in the Project AOI or the surrounding area that meet the cultural heritage definition presented by (UNESCO, 1972). This observation is also true of the logistics support base at Buckhall and the adjacent community, as well as the rights of way on either side of the access road between Buckhall and the Project sites. The only buildings at or near the Project AOI are temporary wood frame or prefabricated modular structures that have been built or erected by Guyana Goldfields, Inc. (GGI) (or by the Barama Logging Company in several locations along the section of the access road that Barama constructed and manages) over the last several years specifically to support exploration or operational phase activities.

With respect to archaeological and/or natural sites, GGI commissioned a detailed evaluation of the archeological setting of the Project in 2012 by a recognized expert in Guyanese

archaeology, Dr. Mark Plew.¹ This investigation indicated that although likely very rare, some potential could exist for certain types of archaeological finds (e.g., pottery sherds or stone implements of potential Amerindian origin) to be encountered in the Project area, particularly on the access road to the mine near the Tapir Crossing barge ferry landings. The full text of Dr. Plew's report (*Technical Report Identifying the Potential Range of Cultural Resources with the Aurora Gold Mining Project Area, Guyana*) is provided for information as **Appendix 14A**.

The "archaeological and/or natural sites" aspect of cultural heritage has therefore been determined to have some limited applicability to the Project pursuant to PS 8 requirements. It should also be noted that as a condition of GGI's current Environmental Permit (Guyana EPA, 2010), the National Trust of Guyana (National Trust) has expressed an interest in preserving Guyana's historical heritage and has requested to be notified if archaeological deposits or potentially historic objects are discovered. GGI has therefore developed specific measures to identify and protect these resources over the course of Project activity, which are summarized in Section 14.2.

14.2 Protective Measures for Cultural Artifacts

GGI has considered the nature of the potential cultural resources identified in Dr. Plew's study and the specific requirements of PS 8 in the development of standard operating procedure (SOP) GG-25, "Chance Archaeological Finds." GG-25 is administered as an element of GGI's Environmental and Social Management System (ESMS; see Section 7), and will typically be applied in conjunction with SOP GG-08, "Environmental and Social Footprint Surveys." The latter procedure is invoked on all land clearance actions required for Project development, and affected personnel will be trained in the requirements of the procedure in accordance with Section 5.2 of the Project's *ESMS Plan*, the full text of which is provided for information as **Appendix 7A**. Any discoveries of objects or artifacts with potential historical or archaeological significance during such clearance actions will trigger the implementation of SOP GG-25.

GG-25 defines chance finds as "...the discovery of relics or human artifacts with potential archaeological or historical significance...[such as]...human remains, especially in association with artifacts or articles that indicate ritual burial; pottery or pottery sherds; stone tools or implements; or metal, glass, or ceramic objects that could date to the pre-colonial or colonial era." Photographs of potentially significant artifacts (e.g., pottery sherds, stone implements) that could be found in the Project area that were specifically noted in Dr. Plew's report are also provided as examples to GGI personnel. It should be noted that garbage or abandoned objects from past decades of uncontrolled ASM activities are generally not considered to have historical or archaeological significance unless there are clear indications that could link the find to colonial or pre-colonial times.

If any such finds are noted, land disturbance actions will be immediately ceased. The area of the find will be marked and reported to the Project's Environmental Officer, who will investigate

¹ Dr. Plew is a Research Affiliate with the Amerindian Research Unit of the University of Guyana. He serves as a member of the Science Advisory Board of the Walter Roth Museum of Anthropology, and as Guyana's Chief Non-Resident Archaeologist. In the latter position, he works cooperatively with the Walter Roth Museum to direct archaeological research in Guyana. A full *curriculum vitae* for Dr. Plew is included in Section 18 of Appendix 14A.

and photograph the find, record its location using global positioning system (GPS) coordinates, establish appropriate project setbacks pending further investigation, and advise the Environmental Manager. The Environmental Manager will in turn evaluate the find, and if confirmed as potentially significant given the criteria set out in GG-25, prepare an Archaeological Find Report that will be submitted to the National Trust for further evaluation. The ultimate disposition of the find (e.g., controlled excavation and removal from the site, or *in situ* preservation) will be developed as a collaborative effort with the National Trust.

The full text of SOPs GG-08 and GG-25 are provided for information in **Appendix 7C**.

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