ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED TULU KAPI GOLD MINE

TKGM
Tulluu Kaapi Gold Mine | S.C

PREPARED BY

Ts
ENVIRONMENT

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1. INTRODUCTION

1.1. Introduction

The Tulu Kapi Gold Mine Share Company (hereafter the company or TKGM) was granted (Grant Date: 13 April 2015) a large-scale mining licence (i.e. MOM\LSML\81\2015) to exploit a gold deposit in western Ethiopia in 2015. An Environmental and Social Impact Assessment (ESIA) for the project was initially approved in 2015 by the Ministry of Mines and Petroleum with conditions, and an ESIA update subsequently completed in 2020.

Several review and update work done by Golder (2012, 2015, 2019 and 2020) to address the conditions stipulated by MoM, as well as updates to baseline data and infrastructure changes which occurred since the submission of the 1st ESIA report in 2015.

TS Environment Technology Plc (TS Environment) appointed by TKGM to review and update the 2020 ESIA report for approval by competent legal authority. This report is Environmental Social Impact Assessment Report (“ESIA”) that document the updated Environmental Social Impact Assessment (“ESIA”) process undertaken for the TKGM.

The ESIA process has been undertaken in accordance with Ethiopian requirements, specifically the Proclamation No. 299/2002, while considering good international industry practice including IFC PS.

The Environment Protection Authority is the competent authority for ESIA review and approval. When the TKGM ESIA processes initiated, the EPA had delegated authority for certain developments to other ministries. Delegated authority for the mine-related infrastructure was the Ministry of Mines and Petroleum (MoMP) - Environment Development Directorate. The EPA recently revoked sector delegations, and as such is the competent authority responsible for the review and approval of the ESIAs.

1.2. Applicant

The applicant is TKGM, a private company registered in Ethiopia. TKGM was formerly known as KEFI, with the official name change completed in June 2021; as such some previously submitted documents are under the name of KEFI.

Table 1-1Applicant Contact Details

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1.3. Background to the Project

KEFI was formed on 24 October 2006 with a view to creating shareholder value through the discovery and exploitation of gold and copper deposits. The Company’s initial assets were EMED Mining’s exploration interests in Turkey and Bulgaria.

KEFI commenced trading (Code “KEFI”) on AIM on 18 December 2006. Since 2008, the highly prospective Arabian-Nubian Shield has been the Company’s primary focus when it commenced exploration activities in the Kingdom of Saudi Arabia.

In 2009, KEFI formed the Gold & Minerals Joint Venture with a Saudi partner, Abdulrahman Saad Al Rashid and Sons Company Limited, to explore for gold and associated metals in the Arabian Shield. KEFI owns 40% and is the operator of the Gold & Minerals Joint Venture.

The Tulu Kapi gold deposit was discovered and mined on a small scale by an Italian consortium in the 1930s. Nyota acquired the licences in 2009 and then undertook extensive exploration and drilling which culminated in an initial Definitive Feasibility Study ("DFS") in December 2012 based on a 2.0 million tonnes per annum ("Mtpa") processing plant and capital expenditure totalling $290 million. KEFI revised the DFS to reduce capital expenditure to approximately $143 million for a 1.2 Mtpa processing plant and introduce selective mining to increase mined gold grade.

In December 2013, KEFI acquired 75% of the TKGP for £4.5 million. This acquisition cost equates to only $10 per reserve ounce and provides the information collected from historical expenditure of more than $50 million. In September 2014, KEFI acquired the remaining 25% of the TKGP for £750,000 and 50 million shares. On grant of the Mining Licence, the Ethiopian government was entitled to a 5% free carry interest in the TKGP.

The Exploration Licences held by KEFI cover an area of approximately 200 square kilometres over and near the Tulu Kapi deposit.

In 2019, KEFI launched a subsidiary, Tulu Kapi Gold Mines Share Company ("TKGM"), which together with the Ethiopian Government jointly owns the TKGP.

1.4. Feasibility Study

1.5. Project Overview

The proposed Project includes a conventional open pit mining operation and processing plant.

In 2012, Nyota completed an initial DFS which was based on a production rate of 2.1 Mtpa with an annual steady-state production rate of 107 000 ounces of gold (Lycopodium, 2017). Following the acquisition of the TKGP from Nyota, KEFI completed a revised DFS in 2015. The revised DFS reconfigured the approach to focus on a smaller scale selective mining open-pit operation with an annual production rate of 1.2 Mtpa. Subsequent to the 2015 DFS, further project refinements were made to improve cash flows and to reduce costs. These refinements were reflected in 2015 DFS Update. The 2020 Plan incorporates further project refinements which expand early cash flows and reduce stockpiles. Table 2 presents a summary of project refinements from 2015 to 2020.

1.6. Project Concepts

1.7. Project Objective and Justification

The TKGM has identified a new gold deposit. The purpose of the mine development is to utilise the resources to create value and opportunity for the people of the Kurmuk Woreda, Benishangul-Gumuz and Ethiopia, and for the shareholders of KGM.

KGM envisages an initial capital investment of USD 390 million, sustaining life of mine capital expenditure of USD 149 million, and life of mine operating expenditure of USD 1,255 million for the Kurmuk Gold Project. The magnitude of the Project's economic impact can be measured on both a provincial and national scale, with direct benefits associated with employment opportunities, tax and royalty income, training and educational benefits, and export earnings. The project is expected to create 1,400 jobs during construction and 750 jobs during operation, with an expectation of significant indirect and induced jobs during the operational phase of the Project. The households associated with both the project's employees and its suppliers will spend some of their income in the broader economy, generating more economic activity.

The economic benefits associated with the project are expected to contribute to poverty reduction. Poverty levels in Ethiopia have decreased with the implementation of the Governments programme of economic reform;

with those living below the poverty line in the Benishangul-Gumuz Region decreasing from 46.8% in 1996 to 28.9% in 2011 (World Bank, 2015), however progress in rural areas is much slower than urban areas. Development of the project in a rural area is expected to contribute to poverty reduction both economically, but also through non-financial mechanisms to improve standards of living (i.e., education, health, water, and sanitation).

Development of gold resources will contribute to diversification of the national economy from its current focus on agriculture (which accounts for 75 to 85% of the labour force, 40% of the gross domestic product and 80% of exports). As such, development of the project is aligned with the overall aim of the Governments Homegrown Economic Reform Programme to transition from an agrarian low-income nation to an industrialised lowermiddle income country driven by the private sector.

1.8. Approach to the EIS

1.9. Project Team

This EIA report is submitted by TS Environment PLC ("TS"), an accredited environmental consulting company in Ethiopia (as required pursuant to Article 7 of Proclamation 299/2002 dated 3 December 2002) who provide a range of consulting services to governmental, non-governmental and private sector institutions. The relevant contact details for TS are provided in **Error! Reference source not found.** .

Table 1-2: EIA Management Team Contact Details

TS Environmental Technology
Contact: Samuel Hailu
ADDRESS: TK Building, African Avenue, Bole Sub-City
EMAIL: h.samuel@tsenvironment.com
PHONE: +251966685863

TS Environment assigned the following environmental and social professional to complete this report. In addition, as part of the EIA process, an extensive network of independent Ethiopian and international specialists have been involved, as summarised in **Error! Reference source not found.**.

Table 1-3: ESIA Lead Team EPA approved consulatnts

Name	Contact Details
Dr. Tebebe Tafesse	+251911403951
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Table 1-4: EIA Specialist Study - Support Firms and Experts

Role	Responsible for Study	
	Lead Company/ Institution	Supporting Company/ Institution
Hydrogeology	Knight Piésold	Golder Associates Africa (Pty) Ltd.and JEMA
Water quality	SRK Consulting and JEMA Golder, together with GEDAG	
Soils and land capability		JEMA International Consulting Plc
Air quality	SRK Consulting and JEMA	
Noise	SRK Consulting and JEMA	
Biodiversity and NRU	SRK Consulting and JEMA Golder	
Socioeconomics	JEMA International Consulting Plc	
Archaeology and cultural heritage	JEMA International Consulting Plc	

1.10. Statement of Independence

None of the companies listed above have any material present or contingent interest in the outcome of this report, nor do they have any pecuniary or other interest that could be reasonably regarded as being capable of affecting their independence.

1.11. Report Structure

The structure of the report is shown in Table 1-5.

Table 1-5: Structure of this EIA Report

Section	Short Description
Chapter 1: Introduction	Gives general information about the project and its proponent.
Chapter 2: Project Description	Describes the expected infrastructure and management controls of the project upon which the impact assessment was based
Chapter 3: Legal and Regulatory Framework	Identifies legislation relevant to the EIA, the primary approvals that will be required to proceed with the project and the secondary environmental approvals that may be required for specific project operations.
Chapter 4: Approach and Methodology	Provides an overview of the objectives of the EIA and the process undertaken including the scope of work, baseline studies, impact assessment process, and stakeholder engagement requirements.
Chapter 5: Environmental Baseline Description	Describes the existing condition of the physical and biological components of the environment.
Chapter 6: Socio-economic Baseline Description	Describes the current social and economic conditions in the regional and local area.
Chapter 7: Ecosystem Services Baseline	Describes the priority ecosystem services based on the environmental and socio-economic conditions described in the previous chapters.
Chapter 8: Impact Assessment	Identifies and evaluates impacts likely to arise in relation to sensitive natural and human receptors and determines the overall significance of each impact. It includes identification of appropriate management measures.
Chapter 8: Environmental Management	Provides a summary of the system for management of environmental and social impacts and how identified management measures fit within that system.
Chapter 10: Conclusions	Summarises the key findings and outcomes of the EIA process.
Chapter 10: References	Contains references to documentation and other sources of information used in this EIS.
Appendices	

2. PROJECT DESCRIPITION

This Chapter of the report presents an outline of the project description and a revision and update is made only to meet the current mine schedule and programs. All other description and condition presented as per the 2020 ESIA report.

2.1. Project History

The Tulu Kapi deposit was first discovered in the 1930s by an Italian company SAPIE who carried out hydro-mining of gold bearing saprolite and is believed to have produced 947 000 m^3 at a grade of 1.22 g/m^3 for a total of 1 154 kg of gold. The earliest formal exploration of the Tulu Kapi area took place in the 1970s under the guidance of the United Nations Development Programme, who undertook reconnaissance exploration over a wide area of western Ethiopia between 1969 and 1972. The work was largely reconnaissance level and regionally biased and included regional stream sediment sampling, soil geochemical programmes, geophysical surveys, detailed geological mapping, and diamond drilling in the programme.

TREC, a Canadian exploration company, acquired an exploration licence over an area that incorporated the current Tulu Kapi license area and undertook further exploration between 1996 and 1998, including detailed geochemical soil sampling, mobile metal ion soil geochemistry, and an induced polarisation survey. Five diamond drill holes totalling 366 m were drilled in a 200 m by 200 m area immediately north of the old SAPIE mining area which targeted coincident geochemical soil and IP anomalies.

The Tulu Kapi - Ankore Exploration Licence, covering an area of 20.32 km^2, was granted to Minerva Resources through its wholly owned subsidiary Golden Prospect Mining Company ("GPMC") on 27 May 2005. GPMC undertook further detailed geological mapping, trenching, geophysics, and diamond drilling within the licence area.

Data generated by TREC was adopted subsequently by GPMC who geo-referenced it to UTM co-ordinates from local grids. GPMC also undertook trenching in 2006 (two trenches), and, after being acquired by Nyota, excavated a further 14 trenches in 2009.

In May 2009, GPMC conducted additional induced polarisation-resistivity surveys (two profiles aligned along NE - SW direction with a gradient survey) covering an area of 400 m by 400 m. Diamond drilling was carried out on an 80 m by 80 m grid and included 34 inclined holes, centred on gold soil anomalies, to a maximum depth of 200 m. GPMC also undertook additional gradient induced polarisation -resistivity work covering an area of 800 m by 400 m and a ground magnetic survey covering 2.5 km by 1.2 km.

GPMC was acquired by Dwyka Resources Limited (later known as Nyota) in July 2009, making it a wholly owned subsidiary. Following this acquisition an aggressive exploration programme was conducted by Nyota comprising of 14 early trenches, exploration/resource definition drilling and infill resource drilling using both diamond drilling and reverse circulation drilling. Up to March 2012, a total of 151 diamond drill holes, for a total of 42 212 m, including 38 diamond tails for 10 541 m; and a further 203 reverse circulation drill holes for a total of 34 120 m, have been completed at Tulu Kapi.

The Tulu Kapi licence area was originally granted to GPMC in May 2005 as licence number 127-128/97, covering an area of 20.32 km^2. GPMC was acquired by Nyota and became a wholly owned subsidiary in October 2009 and subsequently changed its name to Nyota Minerals (Ethiopia) Limited.

On the 11 May 2011, an application was made to convert the Tulu Kapi exploration licence to a mining licence. This application was approved on the 9 April 2015 by the MoM.

In December 2013, KEFI acquired 75% of the TKGP from Nyota. The remaining 25% of the TKGP was acquired by KEFI in September 2014.

Note, in addition to the Tulu Kapi licence, the TKGP and the conversion application include the adjacent Ankore licence areas, for a total area covered, of 11.33 km^2. The complete area covered of just over 11 km^2 was assessed in the ESIA. All the KEFI exploration licences are in good standing with the Ethiopian government.

2.2. Project Location

The TKGP is located in the Highlands of Western Ethiopia, in Oromia Regional State and in the Genji Woreda administrative district, approximately 360 km due west of the capital, Addis Ababa.

The TKGP is accessible by the main paved road from Addis Ababa, a distance of 520 km with the final 15 km by means of an all-weather unpaved road running through surrounding villages. Chartered aircraft from Addis Ababa may land at the Project’s unregistered grass airstrip at Ayra, approximately 30 km from the Project site, whilst Ethiopian Airlines operate scheduled flights every day to Assosa airport, a 5-hour drive from the Project site.

The Project site is about 9 km south of the village of Keley, which is on the Gimbi to Dembi-Dolo road. Regional population centres within easy road travel distance of the licence areas include Ayra, a small town about 20 km to the west, Gimbi, an important market town about 32 km to the east northeast, and Nekemte, a larger regional centre about 110 km to the east. The Sudanese border is approximately 150 km due west of the Project site.

Geologically and geographically the Project site is comprised primarily of igneous and met sedimentary rocks of Proterozoic age, that form prominent hills and ridges cut by a reticulate drainage system feeding a number of larger perennial rivers, the largest of which is the Birbir River. The Tulu Kapi deposit occurs as a pronounced hummock on a ridge forming a watershed varying in elevation from 1 570 m to 1 770 m above mean sea level.

Land use is predominantly agricultural. The ridges are mainly left to open grassland for cattle, the hillsides terraced for seasonal cropping of maize, teff, corn, and other staples. The incised valleys are overprinted by a forest ecosystem providing shade for extensive coffee plantations which is the main cash crop. Rainfall is seasonal with a pronounced “monsoon” period between July and September.

Daily average high and low temperatures range from 32°C and 13°C in May immediately prior to the start of the wet season, to 24°C and 14°C in July and August which are the coldest months. The regional location of the Project site is shown in Figure 2-1.

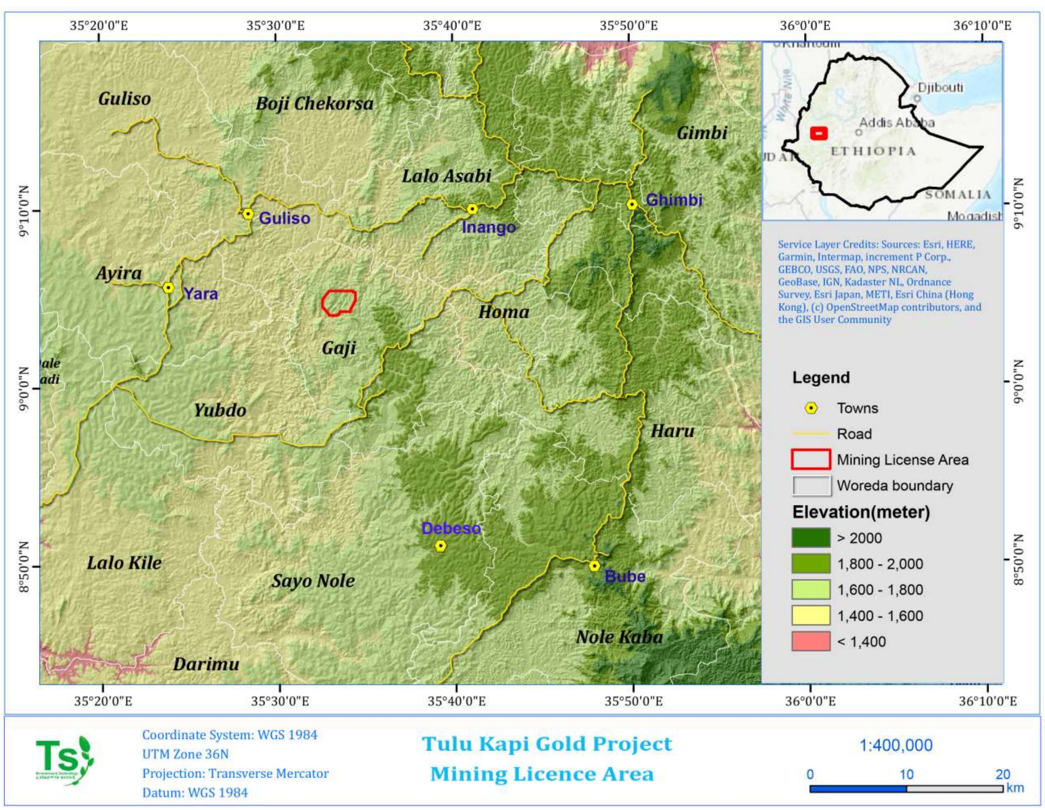


Figure 2-1 project location

2.3. Project Overview

The proposed Project includes a conventional open pit mining operation and processing plant.

In 2012, Nyota completed an initial DFS which was based on a production rate of 2.1 Mtpa with an annual steady-state production rate of 107 000 ounces of gold (Lycopodium, 2017). Following the acquisition of the TKGP from Nyota, KEFI completed a revised DFS in 2015. The revised DFS reconfigured the approach to focus on a smaller scale selective mining open-pit operation with an annual production rate of 1.2 Mtpa. Subsequent to the 2015 DFS, further project refinements were made to improve cash flows and to reduce costs. These refinements were reflected in 2015 DFS Update. The 2020 Plan incorporates further project refinements which expand early cash flows and reduce stockpiles. Table 2-1 presents a summary of project refinements from 2015 to 2020.

Table 2-1: Summary of changes to the project description from 2015 to 2020 (KEFI, 2020)

Description	Unit	2015 DFS	2015 DFS Update	2020 Plan
LOM[2]	Years	13	10	8
Production rate	Mtpa	1.2	1.5-1.7	1.9-2.1
Total ore processed	Mt	15.4	15.4	15.4
Waste:ore ratio		7.4:1.0	7.4:1.0	7.4:1.0
Average grade	g/t (gold)	2.1	2.1	2.1
Gold recoveries	%	9.1.5	93.3	93.3
Annual steady-state production	Oz	95 000	115 000	140 000
Total gold production	oz	961 000	980 000	980 000

KEFI is in the process of investigating the feasibility of extending the life-of-mine ("LOM") below the 1 400 metres above mean sea level (mamsl) using underground methods. Below this level, there is an existing indicated resource of 1.08 Mt at 5.63 g/t for 200 000 oz of gold. The underground operations are outside of the scope of this ESIA and have only been mentioned for contextual purposes. Should TKGM seek to mine these resources in the future, the ESIA will need to be updated to assess the potential impacts/risks associated with underground operations.

2.4. Project Schedule

In total, the duration of the Project is approximately 10 years, from start of construction in 2023 to end of closure in 2032. Table 2-2 presents a summary of the proposed schedules for the following:

- Mine pits
- WRDs
- Ore Processing Plant
- Stockpiles
- Gold production

Table 2-2: summery Project Schedule

Component	Unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total
Mining													
Stage 1a	kt		1 995	11 588	5 643	-	-	-	-	-	-		19 225
Stage 1b	kt		-	10 574	5 488	3 774	227	-	-	-	-		20 063
Stage 2	kt		-	-	10 367	17 213	15 439	5 615	357	-	-		48 991
Stage 3a	kt		-	-	-	-	2 408	7 604	1 511-	-	-		11 522
Stage 3b	kt		-	-	-	-	1 502	449	-	-	-		1 951
Stage 3c	kt		-	-	-	-	164	5 087	11 110	6 007	95		22 464
Stage 4	kt		-	-	-	-	-	567	327	-	-		894
Total	**kt**		**1 995**	**22 162**	**22 097**	**22 033**	**21 999**	**20 599**	**13 444**	**6 007**	**95**	**-**	**130 430**
Waste rock													
Total waste rock	**kt**		**1 647**	**18 552**	**19 540**	**20 478**	**19 640**	**18 577**	**11 569**	**4 954**	**78**	**-**	**115 035**
Processing													
Saprolite	kt	-	-	522	80	76	72	165	18	-	-	-	934
Fresh	kt	-	-	1 604	2 040	1 897	1 705	627	434	693	1 095	-	10 094
Hard	kt	-	-	-	-	130	303	1 180	1 475	1 262	16	-	4 367
Total ore	**kt**	**-**	**-**	**2 126**	**2 120**	**2 103**	**2 080**	**1 972**	**1 927**	**1 955**	**1 112**	**-**	**15 395**
Stockpiles													
Saprolite	kt		228	226	249	173	102	-	-	-	-	-	-
Fresh	kt		119	1 606	2 019	1 548	1 897	1 952	1 788	1 095			
Hard	kt		-	-	-	-	-	97-	209-	-			
Total stockpiling	**kt**		**347**	**1 832**	**2 268**	**1 721**	**1 999**	**2 049**	**1 997**	**1 095**			
Recovered gold													
Avg. grade	oz/t	-	-	2.54	2.31	1.96	2.43	2.10	2.14	2.03	0.84	-	2.12
Total gold	**oz**	**-**		**156 000**	**141 000**	**116 000**	**147 000**	**118 000**	**118 000**	**115 000**	**27 000**	**-**	**938 000**

2.5. Project Infrastructure

The following section presents a brief description of the main project infrastructure of the TKGP. As mentioned previously, there have been several project refinements since 2012. Consequently, the project layout and main infrastructure has also been refined in recent years and differs to some extent from what was originally presented in the 2012 version of the ESIA.

Figure 2.2 presents the proposed layout of the main infrastructure of the TKGP. This includes the following, which is described in more detail in the sections to follow:

- Mine pits
- Waste rock dumps
- Mine haul road
- Run-of-mine ("ROM") pad
- Ore Processing Plant
- Tailings storage facility
- Water storage dams
- Permanent camp
- Security camp
- Keley to Tulu Kapi access road
- Tulu Kapi substation
- Explosives magazine
- Ancillary mine infrastructure
- Supporting infrastructure

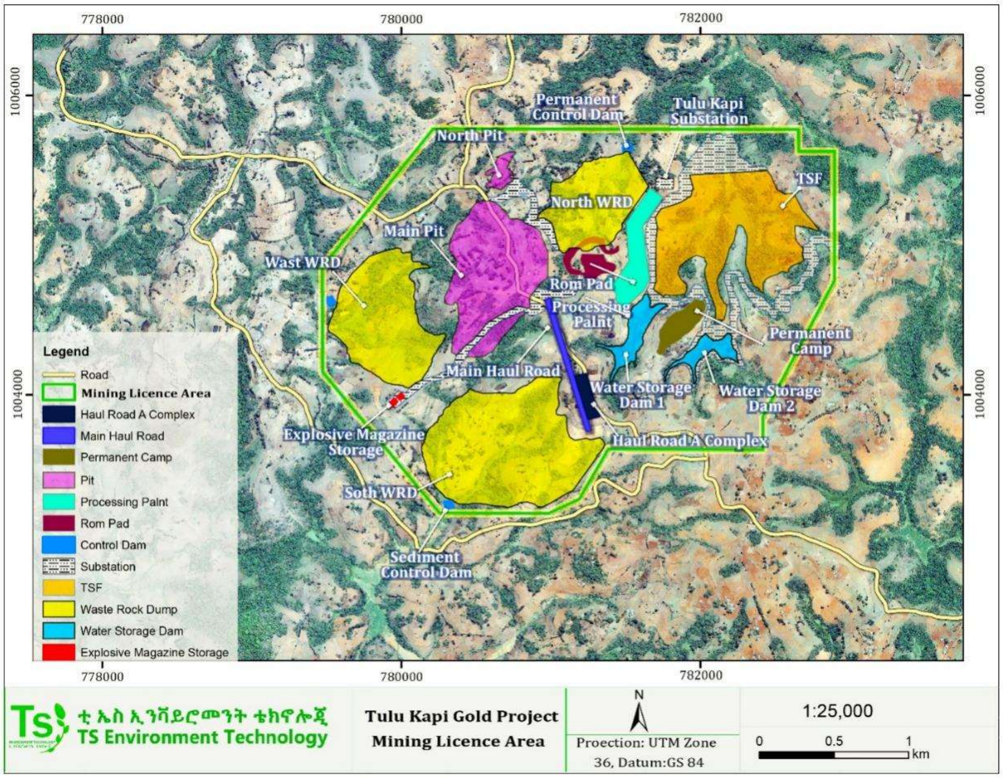


Figure 2-2: Proposed layout of the main infrastructure of the TKGP

2.6. Mine Pits

The TKGP will comprise of two open pits, the main pit, and a smaller northern pit. The main pit will be approximately 49.3 ha in extent, with a maximum depth of 262 m (Snowden, 2015). In total, 1.29 Mt of ore and waste rock will be mined from the main pit. The northern pit will approximately 2.73 ha in extent, with a maximum depth of approximately 15 m. In total, 0.89 Mt of ore and waste rock will be mined from the northern pit.

It is proposed that the two mine pits will be mined in the following four stages in accordance with the schedule presented in Table 2-2:

- Stage 1 (a and b)
- Stage 2
- Stage 3 (a, b, and c)
- Stage 4 (northern pit)

Mining of the pits will be staged to maximise cash flows, while maintaining practical mining considerations. Figure 2-3 to Figure 2-8 illustrate each individual stage.

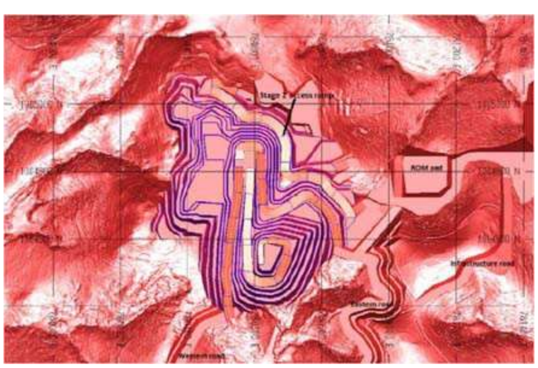


Figure 2-3: Stage 1 (Snowden, 2015)

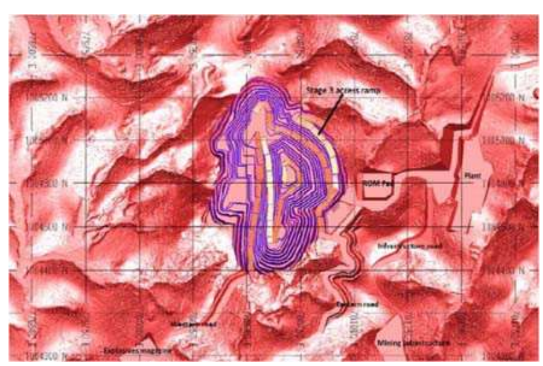


Figure 2-4: Stage 2 (Snowden, 2015)

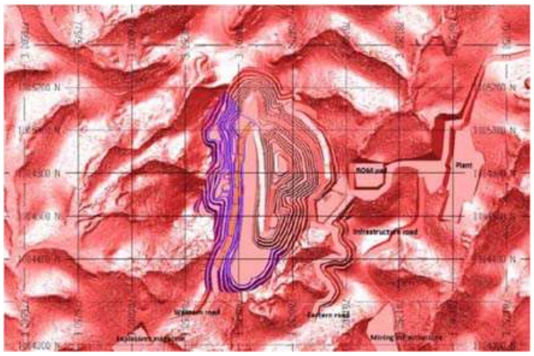


Figure 2-5Stage 3a (Snowden, 2015)

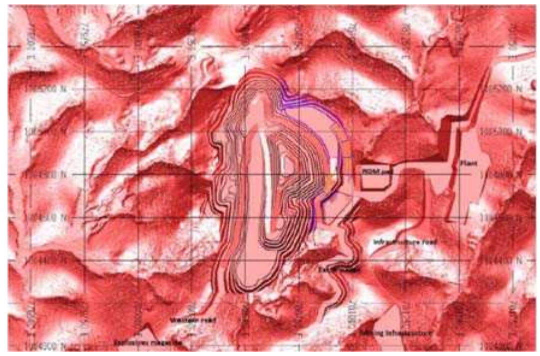


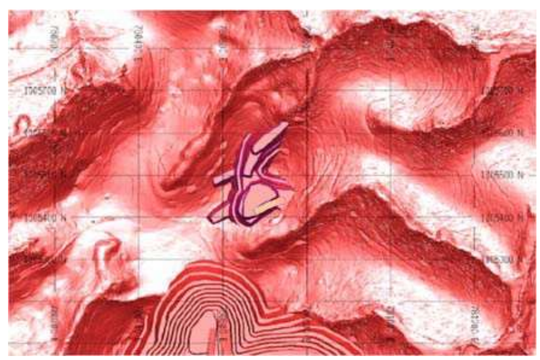
Figure 2-6: Stage 3b (Snowden, 2015)

Figure 2-7: Stage 3c (Snowden, 2015)

Figure 2-8: Stage 4 (Snowden, 2015)

The open pits will be mined by conventional, open-pit methods: drilling, blasting, excavating, and road haulage of ore and waste. In general, mining will progress from west to east when possible to avoid collapsing the ore material into the waste material, as would occur if mined from east to west (Snowden, 2015). The selective mining process to be used at the TKGP will comprise of the following seven steps as illustrated in Figure2- 9:

1) Bulk waste removal
2) Cleaning waste from the hanging wall contact
3) Re handle of selective waste
4) Removal of bulk ore
5) Cleaning of selective ore to the foot wall contact
6) Re handling of select ore
7) Continue mining the waste material



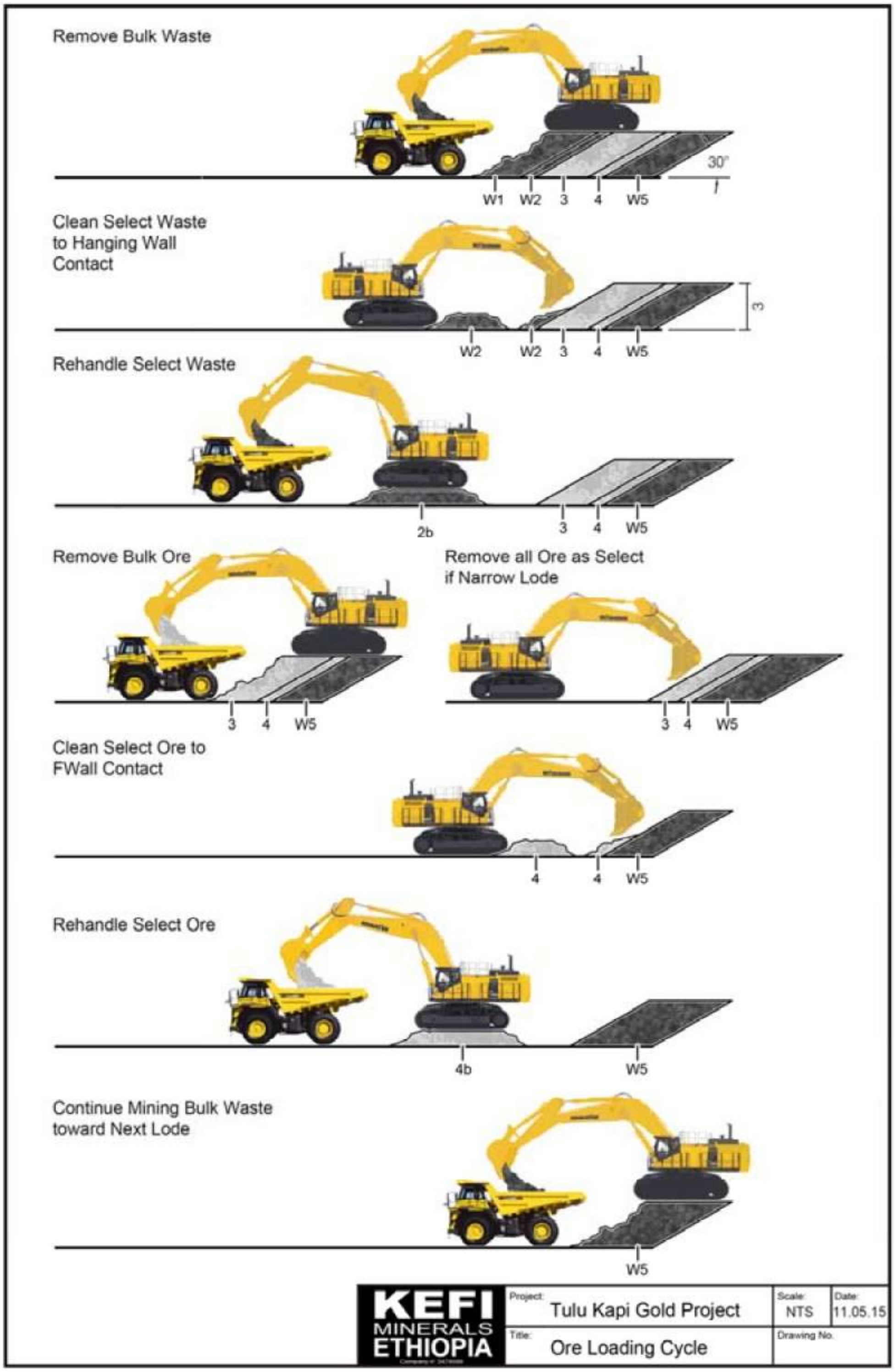


Figure 2-9: Ore loading cycle

The open pits will generate water by means of groundwater inflow and will also receive direct rainfall (catchment runoff is unlikely to reach the pit due to its elevated topography). Water that accumulates in the pit (including groundwater and rainfall) will be pumped into Water Storage Dam 1 (“WD1”) to supply make-up water to the Ore Processing Plant. Portable pit dewatering pumps capable of delivering 7 Mℓ per day at 150 m total head will be used for pit dewatering.

2.6.1. Quarry Pit

Prior to the start of mining, it is proposed that a quarry pit will be mined to provide material for the construction of the following infrastructure (Snowden, 2015):

- Initial ROM pad for the stockpiling of pre-production ore
- Embankment of the TSF and WD1
- Major road network to provide access to the explosives magazines, mine infrastructure area, bottom of the South WRD, and TSF dam wall
- Initial access to the main pit

The proposed location of the quarry pit and pre-mining construction activities is shown in Figure2- 10.

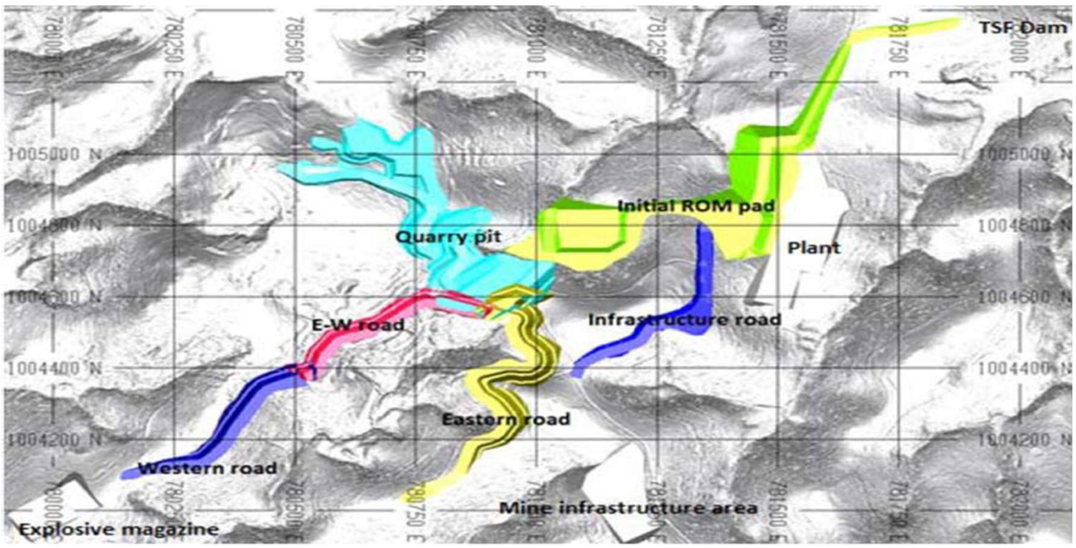


Figure 2-10: Proposed pre-mining construction activities (Snowden, 2015)

2.6.2. Haul Road A

Ore will be hauled to the ROM pad from the open pits via the 24 m wide main haul road. This road will be approximately 1 km in length.

2.6.3. Run-of-Mine Pad

The ROM pad will be used to provide a buffer between the mine and the Ore Processing Plant (Lycopodium, 2017). The ROM stockpile will allow for the blending of feed stocks to ensure consistent feed type and rate to the plant. A mobile rock breaker at the ROM pad will be used to break oversize rocks The ROM pad will be approximately 5.34 ha in extent and designed to accommodate 500 000 t of ore. Ore from the ROM pad will be transported to the primary crusher by conveyor.

2.7. Waste Rock Dumps

Mine waste, and other waste materials will be generated throughout the life of the Project. Mine waste accounts for the major proportion of waste materials and comprise natural waste rock and soil materials. Some mine waste will be reused in construction, but the majority will be stored in permanent waste dumps.

Table 2-3 presents the predicted waste quantities generated each year during the LOM. This schedule is based on preliminary pit optimisation design work, and the predictions will be reviewed and updated regularly during the life of the mine. According to this schedule, the WRDs are required to contain a total of 115 035 000 t of waste rock.

Tulu Kapi will operate three waste rock dumps – one to the west, one to the north east, and one to the south of the main pit (Figure 11). The approximate footprint dimensions of the waste dumps at closure are summarised in Table 4. Note that the West WRD has been split into two phases: Options A and B. It is likely that only Option A will be utilised (3 900 000 m^3 or 8 200 000 t), however should additional storage space be required then it may become necessary to utilise Option B (15 300 000 m^3 or 32 130 000 t).

Table 2-3: Mine waste dump footprint dimensions (Golder, 2015)

Waste dump area	Area (ha)	Storage capacity (m^3)	Storage capacity (t)
South WRD	75	49 500 000	104 000 000
North WRD	32	15 100 000	31 700 000
West WRD (Option A and B)	45	19 200 000	40 330 000
Total	**152**	**83 800 000**	**176 030 000**

The placement of mine waste will commence with the North WRD and extend generally northwards. Thereafter (approximately 2025), waste will be placed at the southern-most end of the southern waste dump and generally filling northwards. In approximately 2029, the placement of waste in the West WRD will commence. Waste will be end tipped from individual 10 m high benches, leaving fill slopes formed at their angle of repose. Successively higher mine waste layers can be formed in this manner while the lower layers are progressively restored.

The proposed layout and cross-sections of the WRDs during operations are shown in Figure 2-11 up to Figure 2-13 respectively.

2.7.1. Construction of the WRDs

The construction of the WRDs will be performed in stages over the LOM in accordance with the schedule presented in Table 2-2. The first stage of construction will include clearing and grubbing, topsoil removal over the stage area (area dependent on the mine plan), installation of the underdrain (to the stage limit), and construction of the sediment control ponds (Golder, 2015). As each subsequent stage is constructed, the stage area will involve clearing and grubbing, topsoil removal and extension of the underdrain to the stage limit.

2.7.2. Underdrain System

It is expected that rainwater will seep through the WRDs following rainfall events. It is proposed that the seepage will be collected through an underdrain system and discharged into the environment after passing through sediment control ponds located at the lowest point of each WRD's footprint (Golder, 2015).

The underdrain system has been designed as a selected rock fill blanket drain placed at the bottom of the natural drainage valleys which collects flows down the steep topography and provides a positive drain for the WRD and subsequently will reduce pore pressure within the waste fill. The blanket drain extends to the lowest point in the WRD footprint area where the flow passes through a sediment control before discharging into the environment.

The blanket drain will have trapezoidal shape with a 5 m bottom width and is 1.5 m thick. The drain will be constructed with selected rock fill and follows the natural ground drainage slope at the bottom of the valleys. An A6 geotextile will completely envelope the blanket drain to minimize the potential for fine particles to clog the drains. The select rock fill grading for the mine waste rock drains is 500 mm to 4.75 mm (< 5% passing 4.75mm).

2.8. Sediment Control Ponds

The sediment control ponds have been designed based on 24-hour rainfall depth of 49mm for a 1:2 year return period and a runoff coefficient of 15% through the waste rock (Golder, 2015). The sediment control ponds will be a minimum of 4.2 m deep, 2H:1V side slope with plan dimensions of: 65 m x 40 m for the North WRD, 60 m x 35 m for the South WRD, 50 m x 25 m for the West WRD (Option A) and 65 m x 40 m for West WRD (Option B). A 0.2m free board was allowed for in the design.

2.9. Closure and Rehabilitation

During final closure and rehabilitation, down chutes will be installed to manage surface water on each WRD (Golder, 2015). At closure, the benches will be graded such that collected surface water flows towards the nearest respective down chute structure. The down chutes will convey the collected surface run-off to an uncapped section of the WRD where the run-off will seep through the waste material and subsequently flow to the sediment control dams via the underdrains. A collection ditch will be installed to collect and discharge surface water flow from the down chutes and any run-on toward the WRDs into the sediment control ponds at closure. The collection ditch will be constructed as a 1.5 m deep trapezoidal open channel, with a bottom width of 2m, 2H: 1V side slope and a grade not less than 0.5% downstream.

Rehabilitation will aim to re-establish vegetation cover on the slopes, thereby reducing their visual impact and minimising erosion from surface run off. The detailed restoration plan will need to be developed prior to the placement of waste, but in general restoration comprises the placement of soil-materials, either site strip or saprolite, over the bench areas to facilitate planting. In detail, the restoration may include the addition of nutrients to facilitate plant growth, and the adoption of drainage measures to control run off across the slopes. The final form of the waste dumps at closure will be reviewed during the LOM.

The proposed layout and cross-sections of the WRDs at closure are shown in Figure 2-11 up to Figure 2-13 respectively.

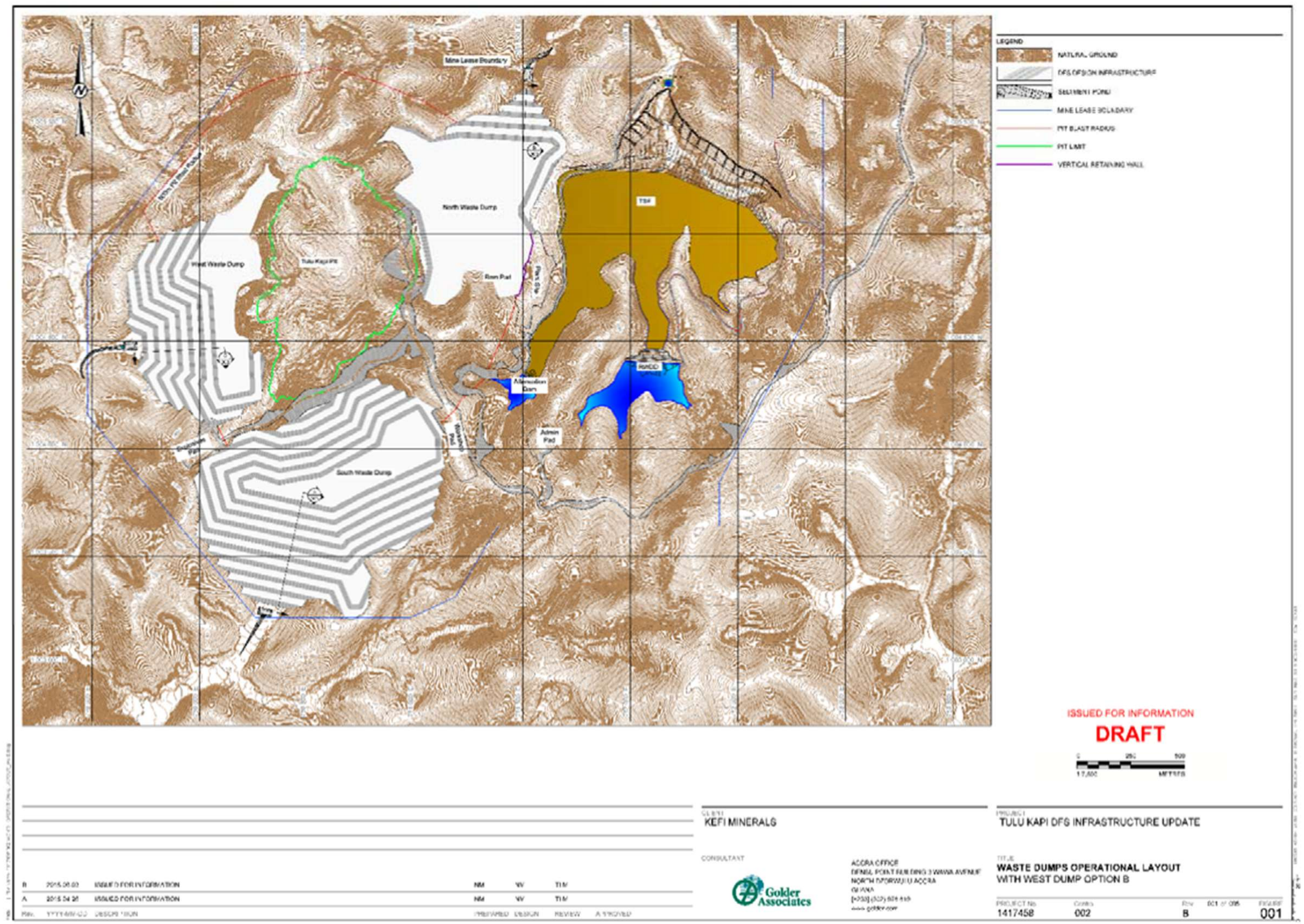


Figure 2-11: Proposed layout of the WRDs during operations (Golder, 2015)

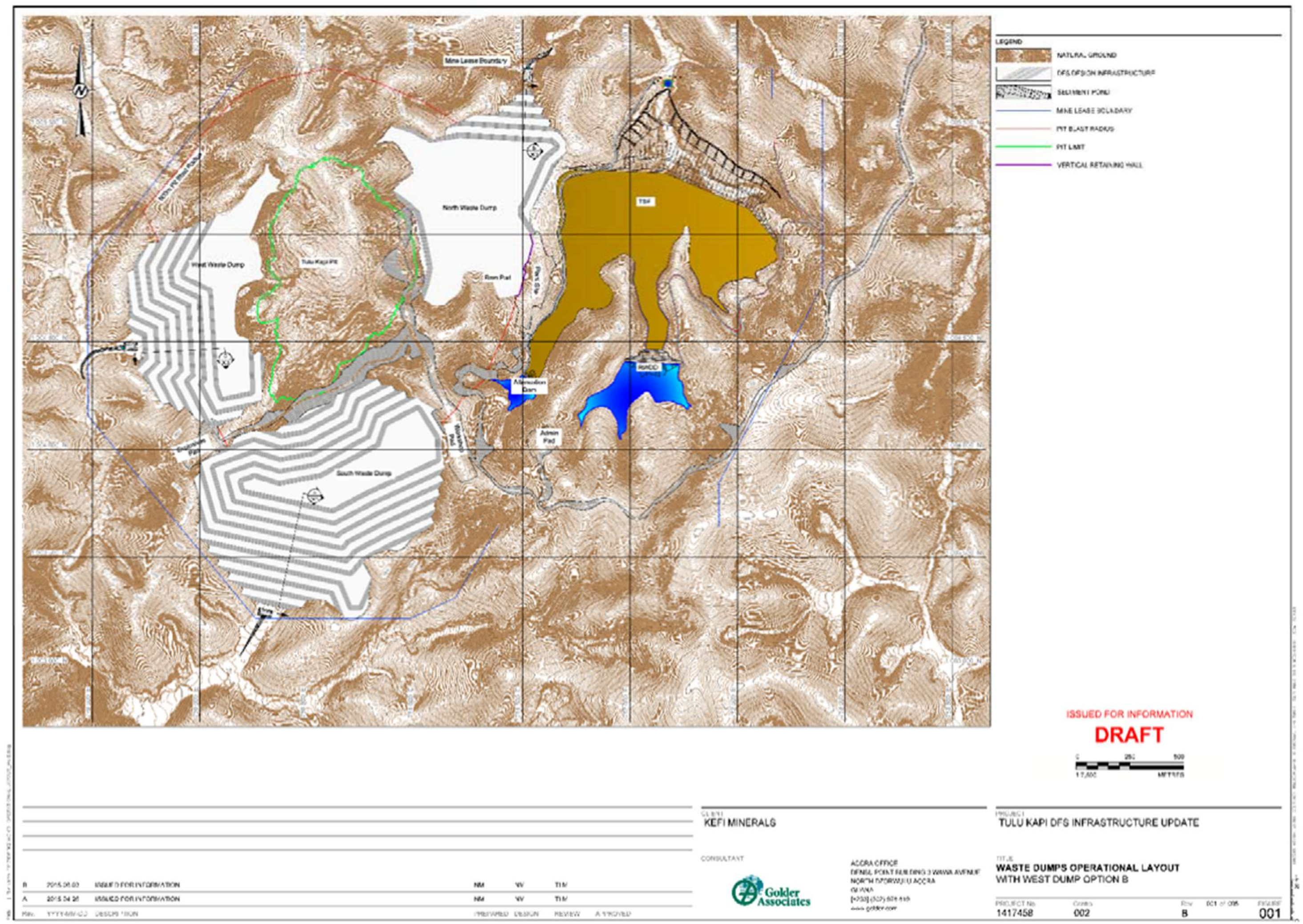


Figure 2-12: Proposed layout of TSF and water storage dams (Knight Piésold, 2020a)

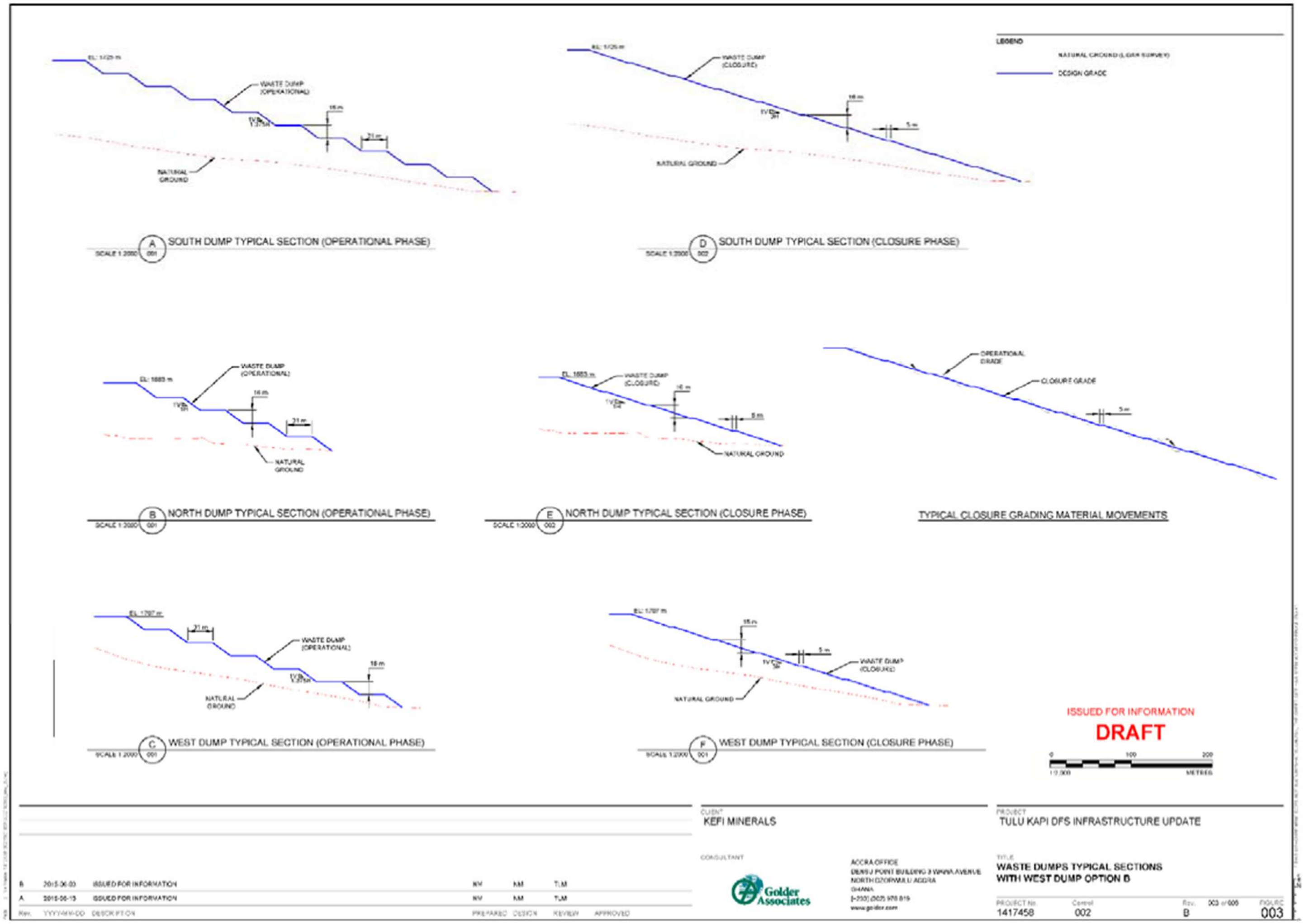


Figure 2-13: cross-sections of the WRDs during operations and at closure (Golder, 2015)

2.10. Ore Processing Plant

The Ore Processing Plant will be designed utilising proven carbon in leach ("CIL") process technology for the processing of oxide, shallow/soft fresh and deep/hard fresh ores. This technology was selected for its durability during the life of the operation, durability, and ease of maintenance (Lycopodium, 2017). The plant has been designed based on a nominal capacity of 1.9 to 2.1 mtpa.

As shown in Figure 2-14, the Ore Processing Plant will comprise of the following components:

- Primary crushing
- Surge bin
- Emergency stockpile
- Lime silo
- Semi-autogenous grinding ("SAG") mill
- CIL
- Acid wash area
- Elution area
- Electrowinning area
- Smelting area
- Carbon regeneration area
- Cyanide detoxification area
- Tailings disposal area
- Reagents
- Water services
- Air services
- Plant control room

TKGM will adhere to gold mining operations verification protocol as detailed in the international cyanide management code (2009) (attached as APPENDIX B).

2.10.1. Primary Crushing

The crushing circuit will consist of a ROM bin grizzly (static), ROM bin, apron feeder, vibrating live deck grizzly, and jaw crusher will be used for crushing ore from the ROM pad to a size that is suitable for the SAG mill (Lycopodium, 2017). The crushing circuit has been designed for a feed rate of 303 dry t/hr (319 wet t/hr) (Lycopodium, 2020).

Ore will be transported from the ROM pad to the primary crushing circuit using dump trucks and dumped directly onto the ROM bin grizzly on top of the ROM bin. This grizzly will scalp off the oversize material which can be broken down to the right size using a mobile rock breaker. The crushing circuit will be treating ore from a maximum lump size of 600 mm to a product size of 80% passing 125 mm suitable for the SAG mill.

A variable speed apron feeder will withdraw ore from the base of the ROM bin and feed a vibrating grizzly (Lycopodium, 2020). Vibrating grizzly oversize will be directed to the jaw crusher and undersize will report directly to the crusher discharge conveyor, bypassing the jaw crusher and thereby reducing the load and wear on the jaw crusher.

The crushing circuit will be controlled by a crushing operator. A front-end loader driver will ensure feed is maintained to the crushing circuit and will communicate with the crushing operator using a two-way radio to supply information on crusher feed operation. The speed of the apron feeder will be adjusted by the crushing operator as required.

2.10.2. Surge Bin

The combined stream from the apron feeder in crushing circuit will be discharged into the surge (or storage) bin. Crushed ore will then be conveyed from the surge bin to the grinding circuit and ore tonnage (wet) will be measured and recorded using a weightometer that will be installed on mill feed conveyor.

Under normal operating conditions, the crushing rate into the surge bin will exceed the rate of withdrawal of ore to the milling circuit. Excess crushed ore will overflow the surge bin and be directed onto the conveyor feeding the emergency stockpile. If the jaw crusher is shut down or there is a shortfall in feed from the ROM pad, the ROM pad front end loader will move to reclaim crushed ore from the emergency stockpile to feed the mill via the surge bin.

The crushed ore will be withdrawn from the surge bin at a controlled rate by a variable speed apron feeder and fed via the mill feed conveyor directly to the SAG mill. A weightometer on the mill feed conveyor will indicate the instantaneous and totalised mill feed tonnage.

A front-end loader will be used to feed grinding media to the SAG mill via the surge bin.

2.10.3. Emergency Stockpile

The emergency stockpile will be used to temporarily store crushed ore. This stockpile will be used to feed the milling circuit when the crushing circuit is off-line.

The estimated quantities of crushed ore that will be stored at the emergency stockpile is presented in Table 2-2.

2.10.4. Lime Silo

The lime silo will be located adjacent the crushing circuit. The silo will be used to temporarily store quicklime which is used for pH control in the CIL circuit. The total storage capacity of the lime silo will be 13 t (Lycopodium, 2020).

The quicklime will be added directly onto the mill feed conveyor feeding crushed ore to the SAG mill. The design capacity of the lime feeder will be 535 kg/hr. The quicklime will be metered using a bin activator and a variable speed screw feeder. The speed of the screw feeder will be varied according to the mill feed tonnage. The operation of the bin activator will be controlled such that the activator will not run if the screw valve is stopped.

The silo will be fitted with a dust collector to minimise dust emissions during loading of quicklime into the storage silo.

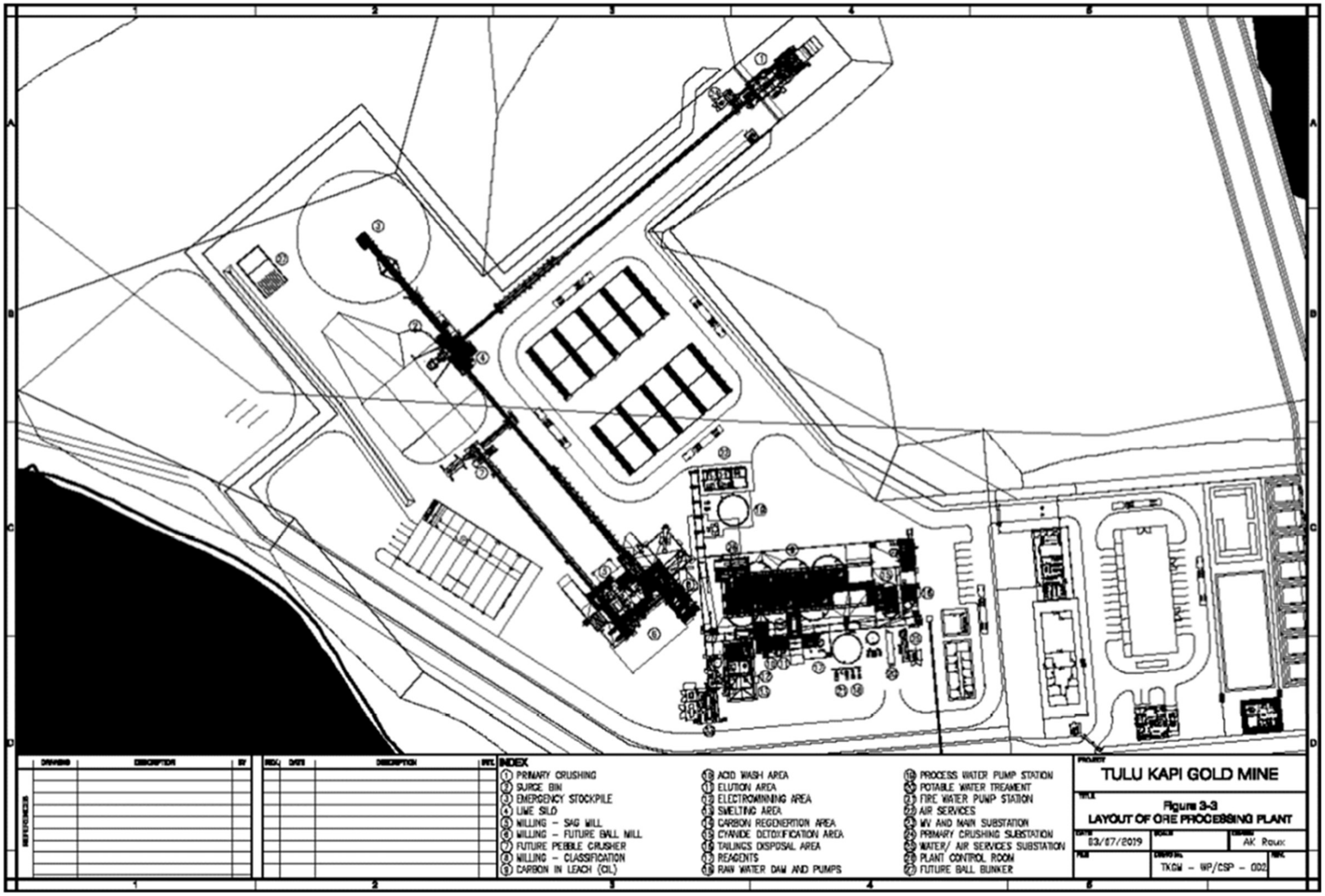


Figure 2 -14: Proposed layout of the Ore Processing Plant

2.10.5. SAG Mill

The milling circuit will consist of a single stage SAG mill fitted with a variable speed drive, a dewatering trommel, cyclone feed pumps, and classifying cyclones (Lycopodium, 2020).

Crushed ore will be fed directly to the SAG mill by the mill feed conveyor. Process water will be added to the crushed ore to achieve the required milling density.

The SAG mill will discharge via a trommel into the mill discharge hopper. The discharge will be diluted with process water and pumped using cyclone feed pumps to the classifying cyclones for classification. SAG mill scats (trommel screen oversize) will discharge to the scats bunker, which will be periodically removed by a bobcat/front-end loader for recycling via the surge bin. Duty/standby cyclone feed pumps will be provided to allow for maintenance with minimum disruption to mill operations.

The number of operating classification cyclones will be remotely managed to match the mill circulating load with changes in mill feed grindability. Three of the classifying cyclones will be fitted with remotely actuated pneumatic inlet valves to cater for normal perturbations to the circuit operation. The cyclone/trash screen platform will be serviced by a davit crane.

The combined overflow stream from the classification cyclones will gravitate to a vibrating trash screen. This screen will be used to remove any misreporting coarse ore particles, wood fragments, organic material and plastics that may become locked in the carbon circuit and 'peg' the interbank screens. The trash will report to a bin for periodic removal and disposal. The cyclone underflows will be collected in the underflow launder and gravitate to the SAG mill feed spout.

Mill area spillage will report to a drive-in sump. A sump pump will be used to dewater the sump. A manual hoist will be used to raise and lower the sump pump depending on the depth of spillage in the sump. Coarse spillage will be reclaimed from the sump by a front-end loader and recycled via the surge bin.

Presently pebble crushing is not included in milling circuit as it not required. Space has been made for a pebble crusher if it is required the future. This is however outside of the scope of this ESIA and has only been mentioned for contextual purposes.

2.10.6. Carbon in Leach

The CIL circuit will consist of six (6) interconnected leach tanks, which will be used to recover the dissolved gold via adsorption onto the surface of activated carbon.

Underflow from the trash screen in the milling circuit will gravitate to the CIL feed distribution box where it will be mixed with a sodium cyanide solution. A ring main system will also be installed for the staged addition of a sodium cyanide solution to CIL Tanks 1 to 3. The slurry will then flow by gravity through the CIL tank train. Each tank will be fitted with a dual impeller, mechanical agitator to ensure uniform mixing, as well as a woven wire interbank screen to retain the carbon in the tank. All tank launders will have bypass facilities to allow any tank to be removed from service for agitator or screen maintenance. As mentioned previously, quicklime will be added directly to the mill feed conveyor to ensure that the pH of the slurry is suitable for cyanidation. Blower air will be distributed to all tanks and sparged down the agitator shafts to oxidise potential cyanicides and to provide dissolved oxygen for the gold dissolution reaction.

Fresh/regenerated carbon will be returned to the circuit at CIL Tank 6 and will be advanced counter current to the slurry flow by pumping slurry and carbon from CIL Tank 6 to CIL Tank 5 and so on. The intertank screen in CIL Tank 5 will retain the carbon whilst allowing the slurry to flow by gravity back to CIL Tank 6. This counter-current process will be repeated until the carbon eventually reaches CIL Tank 1, the first adsorption tank.

A recessed impeller pump will be used to transfer slurry to the loaded carbon recovery screen mounted above the acid wash column in the elution circuit. The carbon will be washed and dewatered on the recovery screen prior to reporting to the acid wash area. The associated slurry and wash water will return to CIL Tank 1. Slurry from the last CIL tank (CIL tails) will gravitate to the carbon safety screen to recover any carbon leaking through worn screens or overflowing the tanks. Screen underflow will gravitate to the cyanide destruction feed box. Safety screen oversize (recovered carbon) will be collected in the fine carbon bin for potential return to the CIL circuit.

Regenerated carbon returning to the adsorption circuit from the carbon regeneration kiln will be screened on the carbon sizing screen to remove fine carbon and quench water. The sizing screen underflow containing carbon fines will report directly to the safety screen. Barren eluted carbon (bypassing regeneration) will report directly to CIL Tank 6.

Sump pumps at the head and tail ends of the CIL train in accessible positions adjacent to the bund wall will be used to manage any spillage from the tanks. The CIL bund floor will slope to each of these sump positions. The CIL containment bund will cater for spillage and splash but will not be designed to hold the full volume of a tank; any significant overflows will report to the TSF (via concrete trench to plant fence, then earthen trench and gravity into the TSF).

An overhead gantry crane will allow maintenance of the agitators, interbank screens, and carbon transfer pumps. A spare interbank screen and maintenance bay will be provided to allow screen change-out to minimise the time for which a tank will be offline.

2.10.7. Acid Wash Area

Loaded carbon from the CIL circuit will directed to the acid wash area where a dilute solution of hydrochloric acid will be used to remove contaminants, predominantly carbonates, from the loaded carbon. The acid wash improves the elution efficiency, as well as reducing the risk of calcium-magnesium 'slagging' within the carbon during the regeneration process.

The loaded carbon will be recovered using a loaded carbon recovery screen, from where it will be transferred to the rubber lined acid wash column. A dilute solution of hydrochloric acid will be pumped into the acid wash column in an up-flow direction. The loaded carbon will be soaked for approximately 30 minutes. The loaded carbon will then be rinsed with raw water to displace any residual acid. Dilute acid and rinse water will then be directed to the tailing’s hopper for disposal. Acid washed carbon will be transferred to the elution column for stripping.

The acid wash column will be located within a bounded area.

2.10.8. Elution Area

Loaded carbon from the acid wash area will be transferred to the elution area for stripping of gold and silver.

A stripping solution consisting of sodium hydroxide and sodium cyanide will be metered into the strip solution tank together with raw water. The strip solution will be pumped through a recuperative heat exchanger and a diesel fired solution heater package before entering the base of the elution tank. The recuperative heat exchanger will recover heat from the return eluate and will preheat the incoming barren strip solution. The diesel fired solution heater package will raise the temperature of the incoming strip solution to approximately 120°C.

The heated strip solution will flow upwards, in a plug flow regime, through the bed eluting gold and silver from the loaded carbon. The pregnant solution exiting the top of the tank will be cooled through the recuperative heat exchanger and in the process pre-heating the incoming barren strip solution. The pregnant solution will be further cooled by flashing it off at atmospheric pressure.

2.10.9. Electro winning Area

Two electro winning cells operating in parallel will be used to recover gold and silver from the pregnant solution coming in from the elution area.

Direct current will be passed through stainless steel anodes and stainless-steel mesh cathodes within the electro winning cells. The electrolytic action will cause gold (and silver) in solution to form a gold (and silver) rich sludge on the cathodes. The cells will contain sufficient cathodes to provide a high cell pass efficiency to minimise the gold tenor in the spent electrolyte returning to the strip solution tank. The elution/electro winning cycle will continue until the solution exiting the elution column is depleted of gold and silver values.

A sulphuric acid pump will be installed to allow periodic flushing of the heat exchangers to reduce the scaling of the surfaces and maintain heat transfer efficiencies.

2.10.10. Smelting Area

The gold (and silver) rich sludge will be removed from the electro winning cell cathodes by washing with high pressure water jets. The resulting slurry will be filtered in a vacuum filter with the recovered solids being dried in an oven. The sludge will then be direct smelted with fluxes in a diesel-fired furnace to produce doré bars. Slag from smelting operations will be returned to the milling circuit.

Fume extraction equipment will be provided to remove gases from the electro winning cells, oven, and barring furnace.

Both the electro winning and smelting areas will be located inside a secure concrete building, also referred to as the gold room, with restricted access by authorised personnel and vehicles only. The security area will have separate personnel and vehicle access doors and remote closed-circuit television ("CCTV") monitoring. The gold room will be fresh air ventilated to maintain acceptable working temperatures.

The electro winning cells will be located on the upper level to permit gravity solution return to the elution tank and sludge draining. The cells and anode support frame will be serviced by a monorail hoist. The electro winning cell rectifiers will be located outside the gold room building to allow monitoring of the current and voltage settings.

2.10.11. Carbon Regeneration Area

After completion of the elution process, the barren carbon will be transferred from the elution tank to the carbon dewatering screen to dewater the carbon prior to entering the feed hopper of the horizontal carbon regeneration kiln. In the kiln feed hopper, any residual and interstitial water will be drained from the carbon before it enters the kiln. Kiln off-gases will also be used to dry the carbon prior to entering the kiln.

The carbon will be heated to 650 - 750°C in the kiln and held at this temperature to allow regeneration to occur. Regenerated carbon from the kiln will be quenched and transferred to the carbon sizing screen. Carbon sizing screen oversize (regenerated, sized carbon) will return to the CIL circuit and screen undersize (transfer water containing some fine carbon) will gravitate to the carbon safety screen for disposal of the fine carbon in the TSF.

The carbon regeneration kiln will be located at the top of tank level. A local vendor control panel will monitor the kiln status and control the retort temperature to the target set point. Fresh carbon will be loaded into the quench tank using the CIL gantry crane.

2.10.12. Cyanide Detoxification Area

The cyanide detoxification area will consist of a carbon safety screen and one stage detoxification.

CIL slurry tails will gravitate flow via the carbon safety screen to the carbon destruction feed box. This screen will be used for the recovery of any escaped carbon from the CIL circuit. Dilution water will be added on the screen to dilute the slurry from 46% to a density of 40% solids by weight. It is proposed that the carbon destruction feed box will also accept flows from other plant streams directed to tailings including acid rinse, acid area sump pump discharge, and plant laboratory cyanide wastes.

From the carbon destruction feed box, the CIL tailings will flow through two equally sized cyanide destruction reactors in either series or parallel. Sodium Meta bisulphite ("SMBS") and copper sulphate solutions will be dosed in a controlled manner, based on the measured incoming weak acid dissociable (WAD) cyanide levels. Low pressure blower air will be sparged into the bottom of each tank. The cyanide destruction reactors have been sized to allow a one-hour residence time at the design CIL tailings slurry flow rate to oxidise the incoming WAD cyanide to cyanate. The reaction tanks have also been designed to allow for dosing with caustic soda for pH control. However, it is not expected that this will be required under normal operation.

Spillage in the detoxification area will be contained in a bounded area. A dedicated spillage pump will be used to pump any spillage back to the carbon safety screen.

2.10.13. Tailings Disposal Area

The tailings from the cyanide detoxification area will gravitate via an automated sampler (for process accounting and control) into the tailings tank. From the tailings tank, the tailings will be pumped to the TSF by the TSF feed pumps.

2.10.14. Reagents

Reagents will be received onsite in shipping containers, with a minimum of three months' capacity stored on site to ensure that supply interruptions due to port, transport or weather delays do not impact production. Reagent containers will be offloaded from the delivery truck by the site crane and unloaded into the designated storage areas or stacked in a lay-down area until required. Empty containers will be returned with the next delivery. A partitioned undercover reagent storage area will be provided for storage of unpacked reagents.

The following reagents will be stored in this area:

2.10.14.1. Lime

Quicklime will be delivered to the Project site in one tonne bulk bags. Quicklime will be added to the mill quicklime storage silo using an electric hoist and enclosed bag breaker. Quicklime will be metered via a rotary valve directly onto the mill feed conveyor for circuit pH control.

2.10.14.2. Caustic Soda (Sodium Hydroxide)

Caustic soda (sodium hydroxide) will be delivered to the Project site in 25 kg bags of 'pearl' pellets. Caustic bags will be added by hand to the mixing tank via a bag breaker on the receiving hopper. The pellets will be discharged into the mixing tank via a manual rotary vane feeder to prevent splash back from the tank and dissolved in raw water to the required solution strength. The caustic solution will be dosed into the elution circuit and to the cyanide destruction circuit as required.

2.10.14.3. Cyanide

Cyanide will be delivered to the Project site in one tonne boxes containing “bulka” bags of cyanide briquettes. Cyanide briquettes will be added to the cyanide mixing tank using an electric hoist and enclosed bag breaker and dissolved in process water to achieve the required solution strength of 20% w/v. The cyanide solution will be transferred to the storage tank for use in the process. Cyanide will be reticulated to the CIL circuit via a ring main and dosed to the CIL tanks as required. A dedicated pump will provide cyanide solution to the elution circuit.

2.10.14.4. Copper Sulphate

Copper sulphate will be delivered to the Project site in 25 kg bags. Copper sulphate bags will be added by hand to the mixing tank via a bag breaker on the receiving hopper and dissolved in raw water to the required solution strength.

2.10.14.5. Sodium Metabisulphite

SMBS will be delivered to the Project site in 1 tonne bulk bags of solid flake. These will be added to the SMBS mixing tank using an electric hoist and enclosed bag breaker and dissolved in raw water to achieve the required solution strength of 20% w/v. The mixed solution will be transferred to the SMBS stock tank via a transfer pump.

2.10.14.6. Activated Carbon

Activated carbon will be delivered to the Project site in 500 kg bulk bags. Carbon will be added directly to the last adsorption tank, as required for carbon make-up.

2.10.14.7. Grinding Media

Grinding balls will be delivered to the Project site in 200 ℓ steel drums. Balls will be charged to the SAG mill as required via the surge bin.

2.10.14.8. Diesel

Diesel will be delivered to the Project site by bulk tankers and transferred to the bulk diesel storage tank. Diesel will be pumped from the storage tank to the plant day tank for use in the strip solution heater, carbon regeneration kiln and smelting furnace. A header tank will feed the burners for the noted equipment to ensure the correct inlet pressure.

2.11. Water Services

2.11.1. Raw Water

Raw water will be pumped via a pontoon mounted pump from WD1 to the raw water tank at the Ore Processing Plant. The raw water tank will have sufficient capacity to minimise the impact of short, term supply interruptions. Duty/stand-by water pumps will be provided for the raw water distribution in the plant.

2.11.2. Fire Water

Fire water for the Ore Processing Plant will be drawn from the raw water tank. Suctions for other water services fed from the raw water tank will be at an elevated level to ensure a fire water reserve always remains in the raw water tank. The fire water pumping system will contain:

- An electric jockey pump to maintain fire ring main pressure
- An electric fire water delivery pump to supply fire water at the required pressure and flow rate
- A diesel driven fire water pump that will automatically start in the event that power is not available for the electric fire water pump or that the electric pump fails to maintain pressure in the fire water system

Fire hydrants and hose reels will be placed throughout the Ore Processing Plant and other working areas at intervals that ensure complete coverage in areas where flammable materials are present.

2.11.3. Gland Water

Water from the raw water storage tank will be distributed as gland service water using duty/standby gland water pumps.

2.11.4. Process Water

Water will be pumped via pontoon mounted pump from the TSF to the process water tank. The process water will consist of TSF decant return water and raw water make-up. Duty/standby process water pumps will be provided for the plant process water supply.

2.11.5. Potable Water

Raw water will be supplied to the potable water treatment plant for treatment. Potable water will be stored in the plant potable water tank and will be reticulated to the site ablutions, safety showers and other potable water outlets.

2.12. Air Services

2.12.1. Plant and Instrument Air Supply

Plant and instrument air will be supplied from duty/standby air compressors. The air will be filtered and dried before distribution with separate plant and instrument air receivers. A check valve on the instrument air supply

Will ensure the integrity of instrument air supply such that air from the plant air system serves as a back-up for instrument air, but plant air cannot draw down the instrument air system.

2.12.2. Blower Air

Low pressure air blowers will be used to meet the CIL tank leach and the cyanide destruction reactor oxygen requirements.

2.12.3. Plant Control Room

The plant control room will be mounted above the CIL tanks in a central location from which most of the operations can be observed. All CIL control will be manual with a titration and sample preparation facility to allow monitoring of cyanide level and carbon concentration. Shift composite samples of CIL feed and tails will be prepared for laboratory assays.

2.13. Tailings Storage Facility

The waste remaining when gold is extracted from crushed rocks is referred to as tailings. Tailings leave the Ore Processing Plant in the form of slurry consisting of a solid material (sand-like in texture) and process water.

A TSF is a structure used for storing and managing the tailings. In the TSF, the solid material and water separate. The tailings slurry is deposited into the TSF in a controlled manner to systematically fill the TSF from the starter dam perimeter inward towards the centre. The tailings solids will settle out of the slurry into the TSF and the slurry water component is subsequently pumped to the return water storage dam. The water in the return water dam is subsequently pumped back to the Ore Processing Plant for reuse in the plant.

The TSF will be developed in eight stages as summarised in Table 2-4. At the end of the stage 8, the TSF will have a final crest elevation of 1 649 masl and the capacity to store 15.4 mt of tailings (Knight Piésold, 2020a).

2.13.1. TSF Wall

The TSF will be formed by constructing a dam across a shallow natural drainage channel of the Gojo River. The starter wall of the TSF will have a box cut, backfilled with low permeability material to increase the flow path under the TSF wall and assist with improving stability. It is expected that the material excavated from the boxcut could be used for construction of the compacted low permeability zone. The rest of the construction material for this zone should be sourced from laterite/saprolite borrow areas.

The TSF wall will consist of two zones. Zone A will be low permeability material, while Zone C1/C2 will be structural fill (Knight Piésold, 2020a). The structural fill (waste rock material) will be supplied by the mine during the operational phase, but due to the limited availability of structural fill during the construction of the starter wall, the upstream and downstream slopes of the structural fill zone was increased from 1:2.5 (V:H) to 1:1.75 (V:H) or 30° and 1:3 to 1:2 or 26.6° respectively , to reduce the volume of structural fill required. The stability of the starter wall will still be adequate. During the first year of operation, the structural fill zone will be constructed to 1:3 outside slope and the low permeability zone will be reduced to 6 m width.

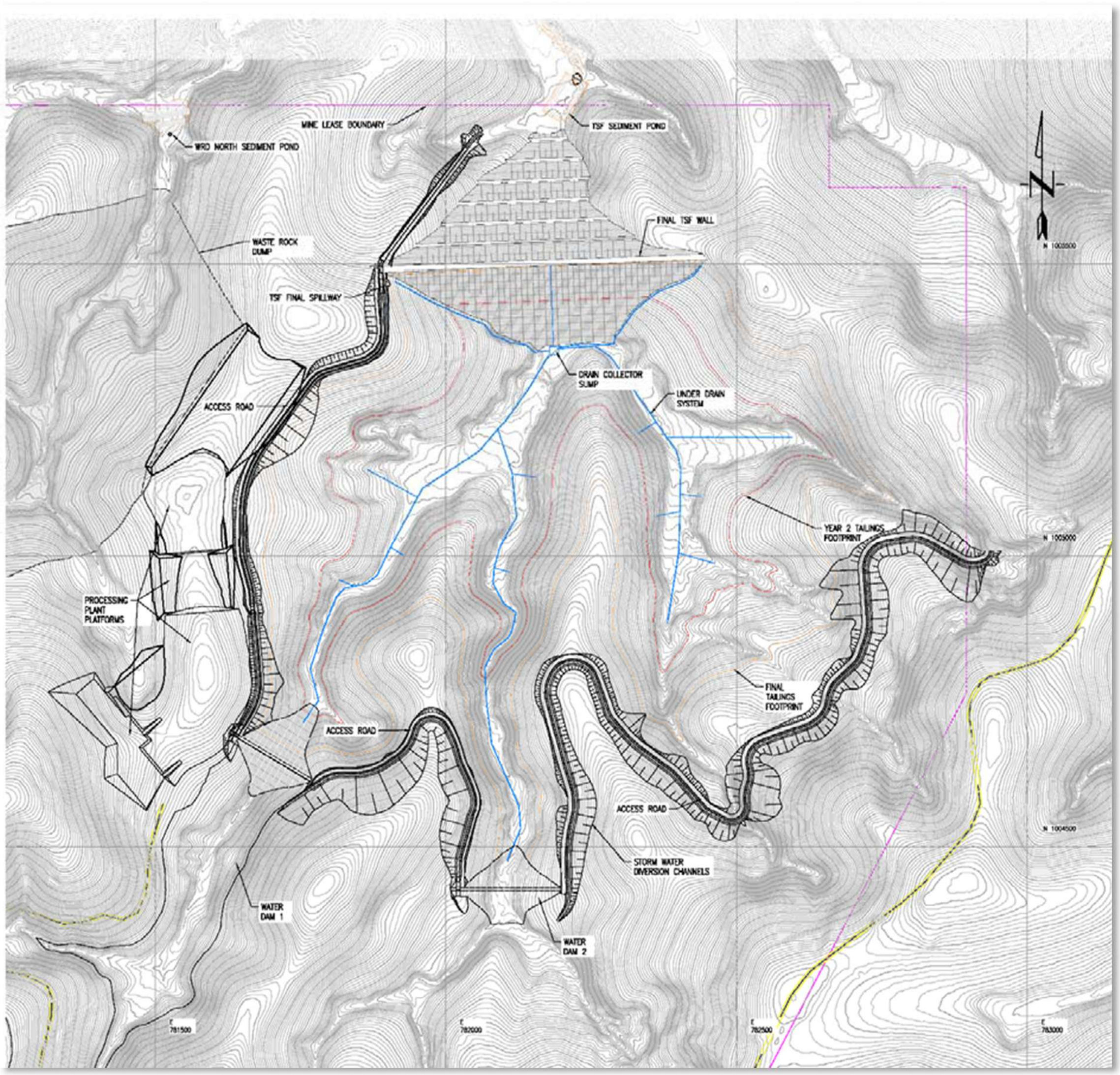


Figure 2-15 : Proposed layout of TSF and water storage dams (Knight Piésold, 2020a)

Table 2-4: Summary of stages of the TSF (Knight Piésold, 2020a)

Parameter	Unit	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8
Time	Year	1	2	3	4	5	6	7	7.7
Space required	Mt	2	4	6	8	10	12	14	15.4
Wall crest elevation at start of stage	mamsl	1 620.4	1 625.8	1 631.2	1 635.6	1 639.4	1 642.8	1 645.8	1 649
Tailings elevation at end of stage	mamsl	1 618.5	1 625.38	1 631.2	1 635.6	1 639.4	1 642.8	1 645.8	1 647.6
Datum level	mamsl	1 596	1 596	1 596	1 596	1 596	1 596	1 596	1 596
Height above datum	m	27.1	32.5	37.9	42.3	46.1	49.5	52.5	55.7
Deposition area	ha	17.7	26.1	32.7	38.6	44.6	49.9	54.9	58.0
Rate of rise	m/annum	9.6	6.2	4.8	4.0	3.4	3.1	2.8	2.8
Structural fill	10^3 m^3	223	221	214	207	206	207	205	376
Low permeability material	10^3 m^3	92	12	15	13	12	11	11	12
Total construction material	10^3 m^3	326	233	229	220	217	218	215	388
Construction rate	10^3 m^3/month	29.6	21.1	20.8	20.0	19.7	19.8	19.6	35.3
Crest length	m	303	341	384	421	482	508	530	561

2.13.2. Tailings Deposition

Various deposition scenarios were investigated to determine the optimum tailings deposition strategy, as shown in Figure 2-16 (Knight Piésold, 2020a). The preferred option includes the following:

- Deposition from the main TSF wall to avoid creating a pool next to the main wall (5, 6 and 7)
- Deposition from the western side (4) to ensure no fine tailings are deposited on this side. If the TSF is to be raised with upstream construction, the stability of the raised wall will be higher if the material under
- the wall is coarser
- Deposition from two of the southern valleys (2 and 3) to allow for two water recovery barges (ensuring all the water will be recovered). Deposition in only one valley (3) was not preferred as not all the water will
- Be recovered. Deposition in third southern valley (1) was also not preferred due to the significant deposition piping that will be required and the distance from water recovery point to the Ore Processing Plant

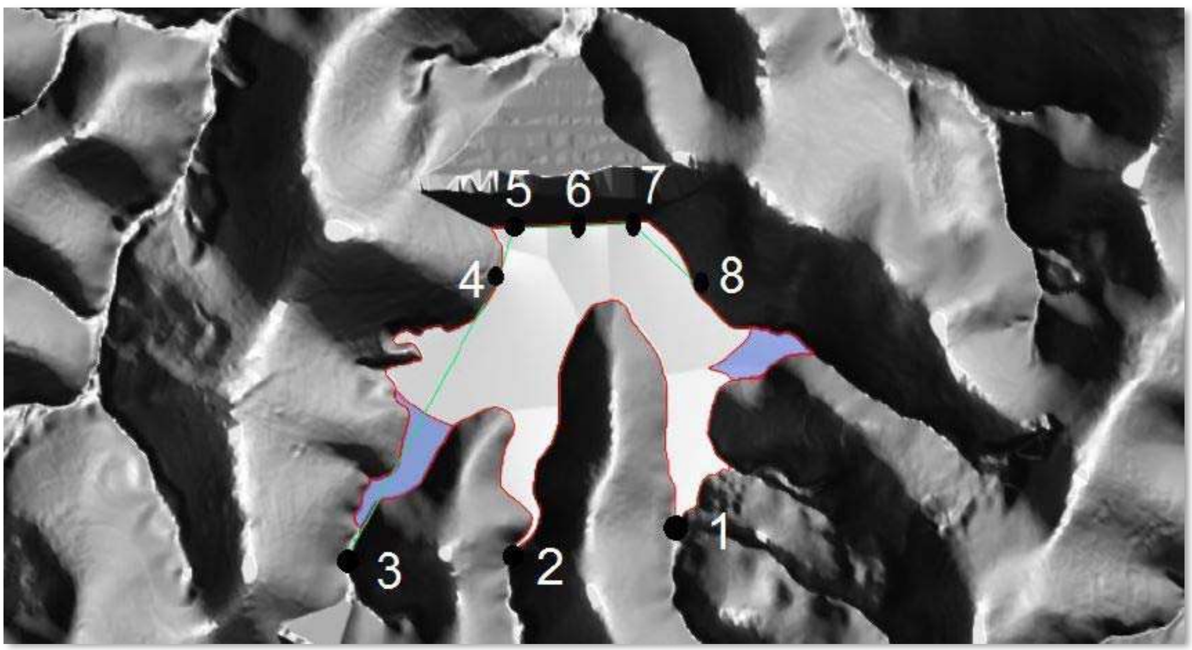


Figure 2-16: TSF deposition scenarios (Knight Piésold, 2020a)

The main tailings delivery pipeline will consist of a 315 mm NB PE100, SDR17 HDPE Pipe, with off takes at approximately 50 m spacing (Knight Piésold, 2020a). The off-take will have a T-piece, reducing to 160 mm, where a 2 m long rubber hose will be connected. The hose will be provided with a spigot clamp to control deposition. The hose will feed into a 250 mm NB slotted PN8 HDPE pipe, that runs down the slope to the bottom of the valley. Approximately 30 spigot pipes will be provided on the main TSF wall and on the western side of the TSF.

2.13.3. Decant System

The preferred option is to use two barges to decant water off the TSF (Knight Piésold, 2020a). These barges will be in the western and eastern valleys. Prior commissioning, the TSF will collect rainwater. The water depth at start of commissioning should be approximately 8 m based on the 186 000 m³ volume stored in the TSF for start-up.

2.13.4. TSF Barrier System

Seepage downstream of the TSF is expected to be minimal due to the low permeability of the laterites and saprolites forming the basin of the TSF (Knight Piésold, 2020a). The barrier system of the TSF will therefore only consist of a 300 mm layer of compacted low permeability material. Where areas of the basin do not have in-situ low permeability material, it will have to be sourced from other areas within the basin.

During construction, regular in-situ permeability tests (large double ring infiltro meter) tests or additional laboratory permeability test can be done to confirm the conditions of the basin.

2.13.5. TSF Drainage System

Perforated pipes will be installed in the toe-drains next to the starter walls as well as in collector drains in the valleys (Knight Piésold, 2020a) – see Figure 15. The collector drains will have two pipes, while the finger drains will have one pipe. The pipes would consist of 160 mm slotted pipes. The pipes will be laid in a 300 mm thick layer of 19 mm stone, followed by 200 mm of 6 mm stone, with a 200 mm thick layer of sand on top of it. The 6 mm stone layer could also be replaced with a separation geotextile, but it has been found that the tailings occasionally blind the geotextile, reducing the effectiveness of the drain.

The sand will be covered temporarily with a geotextile to avoid erosion of the sand layer during construction. The geotextile must be removed prior to deposition of tailings. An alternative to the geotextile cover is to place an additional layer of + 20 mm stone on the sand, which will prevent scouring of the sand by the deposited tailings.

One or two drainage sumps will be provided on the lowest points just upstream of the starter wall to collect all the drain discharge and provide a point where the collected filter water can be pumped out of the TSF. It is recommended to pump this water to the Ore Processing Plant and not back onto the TSF. In the initial phases of the TSF life, the volume of water reporting to this sump will be significant, but it is expected that the water will

Eventually reduce to 1 – 2 ℓ/s. Note that the TSF is commissioned with water only and the tailings will take

Several years to cover all the drains and systematically reduce the inflow.

Strip drains will also be installed under the TSF wall to avoid a build-up of the phreatic surface within the TSF embankment. These drains will be approximately 3 m wide and 1 m deep.

2.13.6. Sediment Control Pond

A sediment control pond will be constructed downstream of the TSF main embankment (Knight Piésold, 2020a). The pond will be approximately 3 560 m^2 in extent, with a depth of 3.3 m, and volume of 6 521 m^3. The pond will consist of an excavated pond, with a channel exiting the pond at the pond base level. The opening into the channel will be closed with a rockfill barrier, to collect and slowly release surface/seepage water from the facility to allow medium silt-sized particles (0.006mm diameter) to settle before discharging collected surface water into the environment. The rock fill barrier will be constructed with mine waste rock fill, which will consist of mine waste rock excavated from the mine pits or from the onsite quarry. The size of the pond is based on a design 24-hour rainfall depth of 72 mm for a 1:2-year return.

2.13.7. TSF Emergency Spillway

An emergency spillway was designed for the TSF at its final height (Knight Piésold, 2020a). The spillway will comprise a 10 m long side channel spillway with an ogee profile, a concrete encased culvert thought the dam and a spillway chute. The spillway invert elevation will be at RL 1 648 m. Two no. 300 mm HDPE pipes will be included in spillway structure. These pipes will have an invert elevation at RL 1 647.4 m and will prevent the

Pool elevation from exceeding the maximum allowable level. This measure was implemented in the design to improve the flood dampening in the TSF basin, thereby reducing the required size and cost of the spillway chute.

The TSF emergency spillway will discharge to the environment via a rectangular-shaped concrete chute on the left flank of the TSF. A Manning's n value of 0.02 was used to size the chute, while an n value of 0.01 was used to size the submerged roller bucket energy dissipator terminal structure. The longitudinal profile of the chute follows the ground profile and varies between 10 % and 40 %. The chute has a bottom width of 5 m, depth of

1.5 m and concrete thickness of 0.25 m. The chute will be underlain by a geonet drainage layer reporting to strip drains to each side of the chute.

2.13.8. Clean Water Diversion Channels

To minimise the clean water catchment area upstream of the TSF, three diversion channels and two diversion dams (WD1 and Water Storage Dam 2 ("WD2")) will be installed, as shown in Figure2-15 above (Knight Piésold, 2020a).

It is proposed that Diversion Channel 1 to the east of WD1 will be constructed during the first dry season after the commissioning of the Ore Processing Plant (Knight Piésold, 2020a). The alignment and longitudinal profile of the three diversion channels was selected to balance the required cut and fill volumes, while maintaining a relatively flat longitudinal profile (0.5 %) to minimise flow velocities. The diversion channels have been sized to accommodate the 1:50-year flood plus adequate freeboard. Importantly, the channel sections immediately downstream of the spillway systems of WD1 and WD1 were sized to accommodate a larger flood, with the same flood handling capacity as the spillways. Emergency reject weirs will also be included in the diversion channels as close as practically possible to WD1 and WD1, to discharge flows in excess of the 1:50-year flood event. The channels were sized according to the 1:50-year requirement downstream of the emergency reject weirs.

Contamination Interception System

Two-dimensional seepage modelling indicates that TSF seepage will gradually mix with and displace background groundwater and move downstream, as shown in Figure 2-17. The velocity of groundwater flow is estimated to be less than 1 m/year in the bedrock (KCB, 2020). The extent of the TSF seepage front is therefore expected to be limited to a few hundred metres from the TSF toe as shown

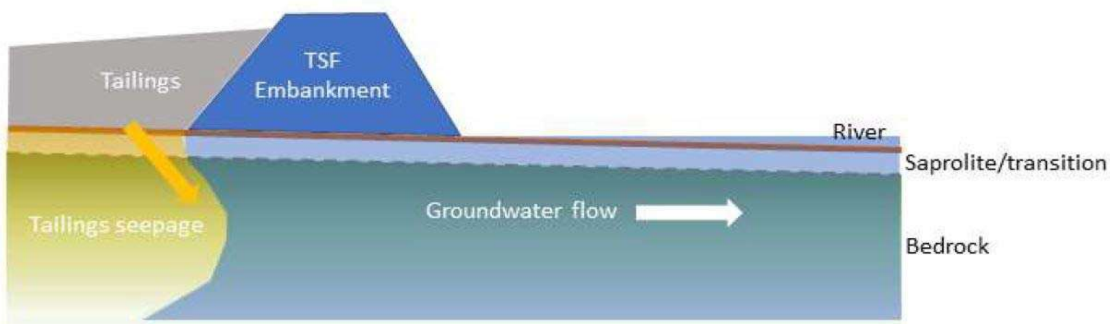


Figure 2-17: Conceptualised tailings seepage (KCB, 2020)

In order to effectively manage the contamination plume from the TSF, a contamination system which consists of a trench and interception boreholes is proposed (GPT, 2020). The trench will be used to intercept seepage and will extend from the top of the clay layer, but not deeper than 1 m. The trench will be constructed with free-

Draining permeable material on the TSF side and impermeable material on the downstream side. The interception boreholes will be located at 80 to 100 m intervals along the down-gradient side of the TSF in order to sufficiently lower the water level to below the saprolite layer (10 to 15 m below ground level). The interception boreholes will be drilled to a minimum depth of 50 m, with a minimum diameter of 165 mm to allow for the installation of a submersible pump. It is proposed that there will be five interception boreholes, four monitoring boreholes located in between the interception boreholes, and nine shallow boreholes which only penetrate to the depth of the clay layer. The shallow boreholes will monitor groundwater quality above the clay layer.

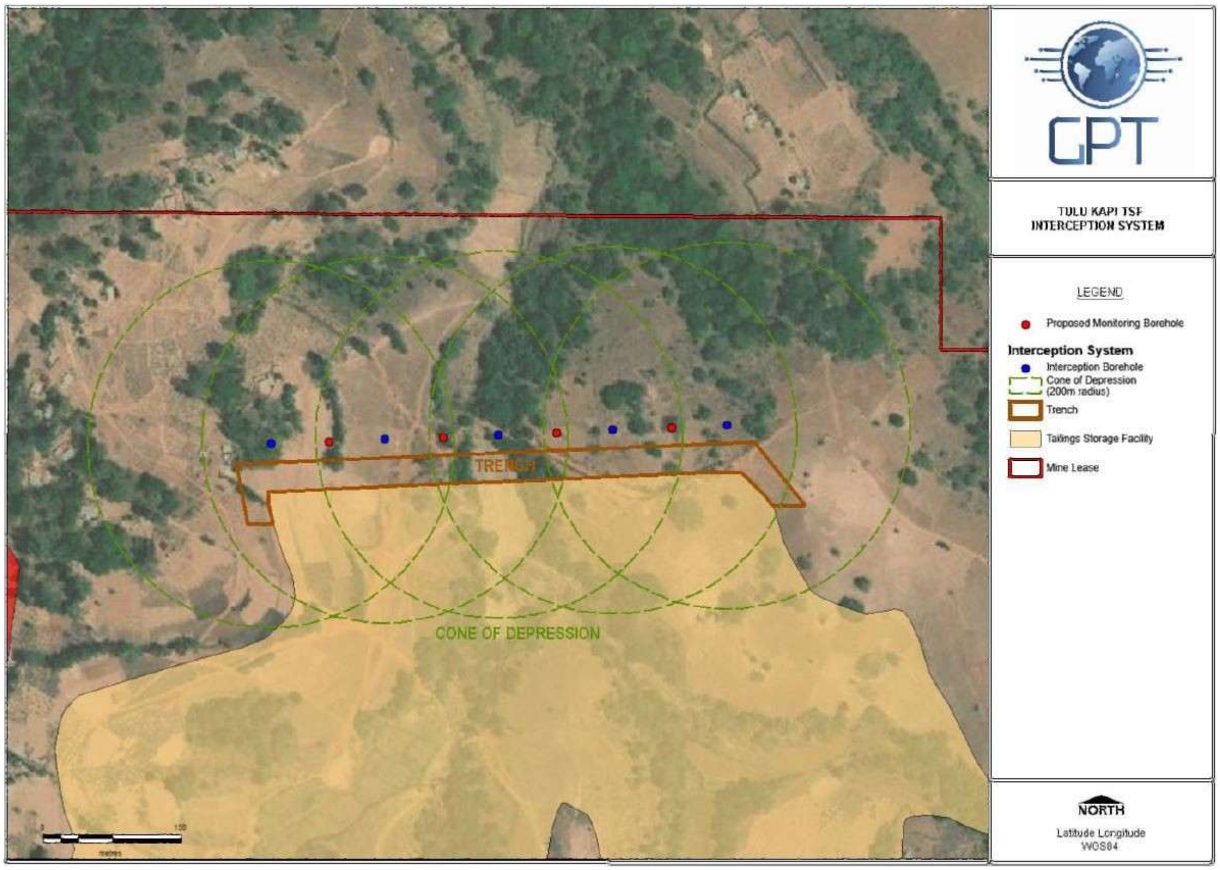


Figure 2-18 : Proposed contamination interception system (GPT, 2020)

2.14. Stability Analysis

In addition to the seepage assessment, Knight Piésold (2020a) also undertook a slope stability assessment of the TSF wall using RS2 and Slide software from Rocscience. The stability analysis was undertaken using the finite element method ("FEM") and limit equilibrium method ("LEM") for static and pseudo-static conditions in four phases. Table 2-5 presents a summary of the conditions used in the slope stability assessment.

Table 2-5: Slope stability conditions (Knight Piésold, 2020a)

Boundary/condition	Value	Unit	Comment/source
Seismic coefficient	0.02	-	

Pool distance away from crest	20	m	
Crest elevation	1 620.4 – 1 649	mamsl	4 phases
Zero pressure			At toe drains, when functional
LEM method	Morgenstern-Price		Block search limited to 5 m deep

As shown in Table 2-6, the stress reduction factor (“SRF”) and factor of safety (“FoS”) is acceptable (> 1.5) in all four phases. This is largely due to the rock fill material used for constructing the outer zone of the TSF wall.

Table 2-6: Slope stability results (Knight Piésold, 2020a)

Phases	Wall height (mamsl)	SRF (FEM)	Static (LEM)	Pseudo-static (LEM)
1	1 620.4	2.26	1.66	1.567
2	1 633	2.88	2.089	1.954
3	1 641	2.84	2.146	2.002
4	1 649	3.25	2.356	2.175

2.14.1. Liquefaction Potential

Soil liquefaction describes a phenomenon whereby a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress or sudden change in stress condition, causing it to behave like a liquid (Knight Piésold, 2020a). It is expected that the liquification potential of the TSF is low due to the following reasons:

- The embankment breach is unlikely as the wall will be raised in time to always maintain a minimum 0.8 m freeboard
- The particle size distribution indicate that the tailings percentage finer than 0.005 mm is not in the range of potential liquefaction (<15%)

2.14.2. Safety Classification

The purpose of the safety classification system is to provide a consistent means of differentiating between high, medium, and low hazard deposits based on their potential to cause harm to life or property (Knight Piésold, 2020a). The zone of influence of the TKGP’s TSF was calculated using a crest elevation of 1 649 mamsl and in accordance with SANS 10286 (Figure2- 19).

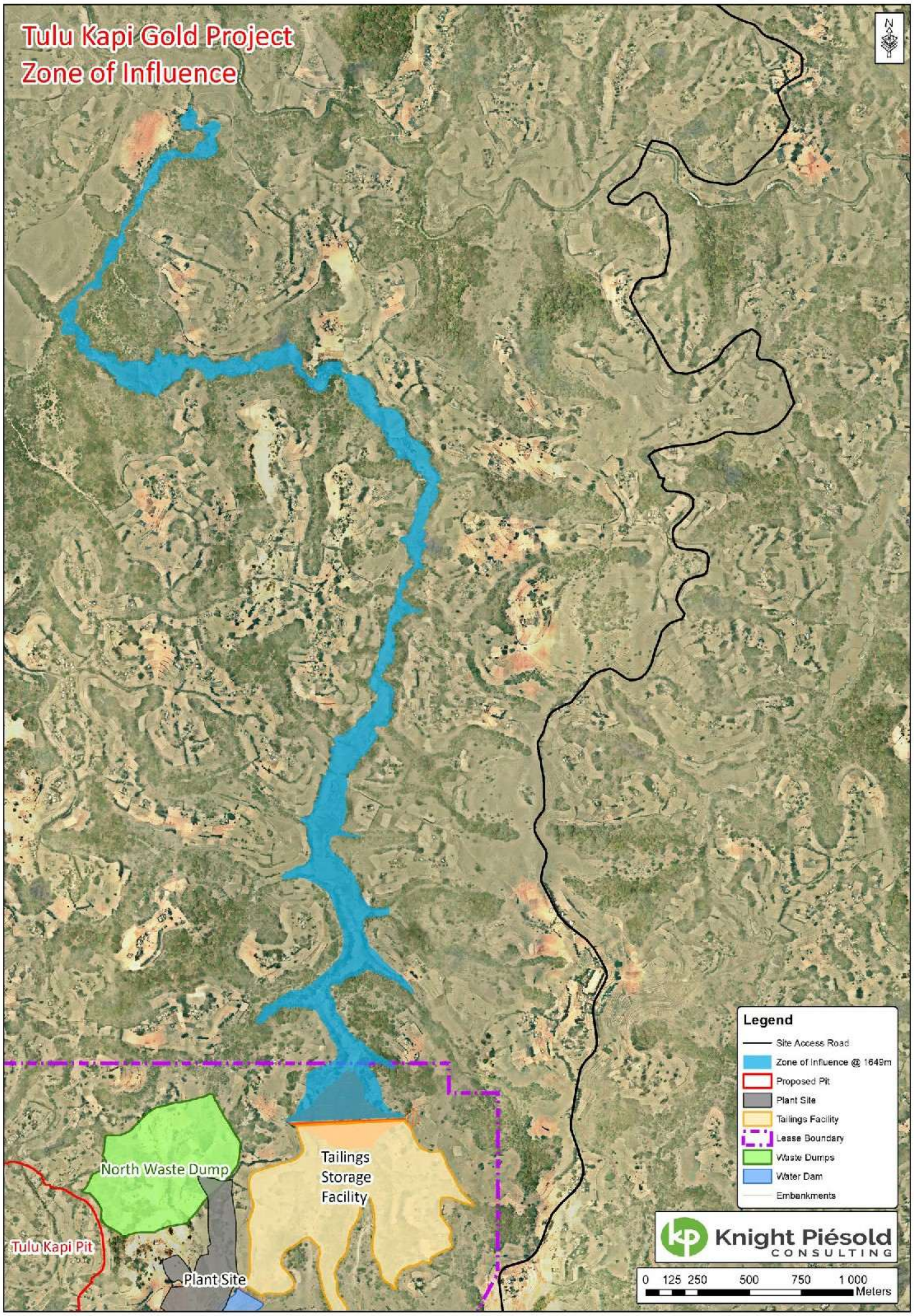


Figure 2-19: TSF zone of influence (Knight Piésold, 2020a)

Based on the criteria presented in Table 2-7, the TSF is classified as a medium hazard. The medium classification is largely a function of the remoteness of the location which reduces the risk of loss of life or property damage in the event of the TSF failing.

Table 2-7: SANS 10286 safety classification criteria (Knight Piésold, 2020a)

No. of residents on zone of influence	No. of workers in zone of influence	Value of 3rd party property	Depth to underground mine workings	Classification
0	< 10	R to R 2 million	> R 200 million	Low hazard
1 to 10	11 to 100	R 2 to R 20 million	R 50 to 200 million	Medium hazard
>10	>100	>R 20 million	< R50 million	High hazard

2.15. Dam Break Analysis

A tailings dam break analysis was undertaken to determine the dam failure consequence classification of the facility (Knight Piésold, 2020a). The analysis was based on a crest elevation of relative level (“RL”) 1 649 m with a tailings filling elevation of RL 1 648 m. The analysis used a “sunny day” failure scenario where the TSF pond was allowed to fill up to the spillway invert elevation after a large storm or due to negligence. The TSF then fails rapidly due to an unspecified failure mechanism. A total pond volume of 1.457 million $m1^3$ was used for the analysis.

The dam failure consequence classification of the TSF was based on number of criteria, including population, loss of life, environmental, cultural, infrastructure, and economic losses. A ‘high’ dam class was assigned to the TSF for the following reasons:

- One house was identified within the calculated inundation boundary. The permanent population at risk is estimated at 5 persons
- The loss of life due to a failure is expected to be less than 10 persons
- Significant loss of habitat is expected due to pollution of the downstream watercourse by tailings
- Significant areas of arable land may be impacted – restoration or compensation in kind will be required
- Flooding of local public access will disrupt public transportation

Figure 2-20 presents the outcomes of the sunny day” failure scenario.

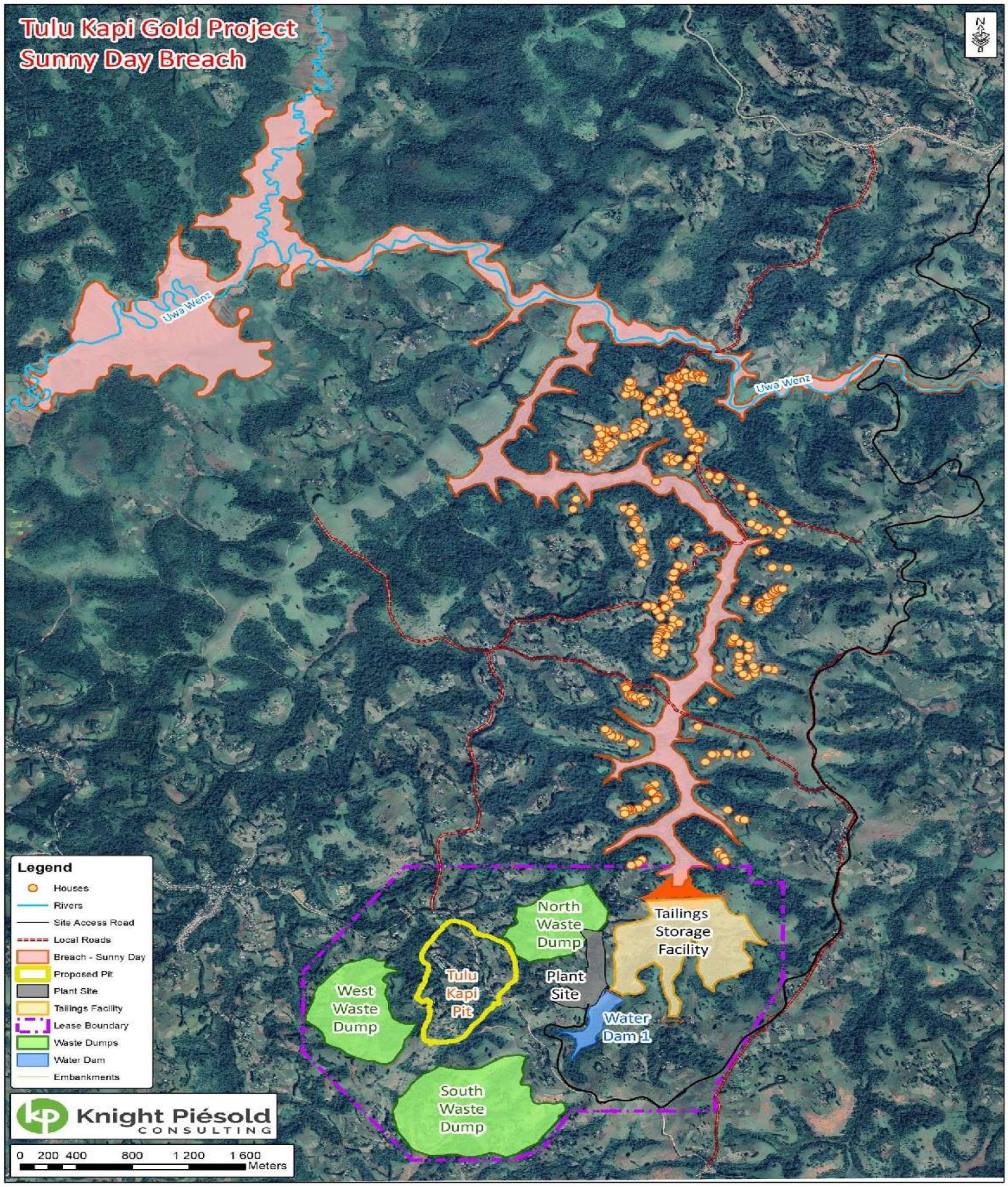


Figure 2-20: Sunny day breach failure scenario (Knight Piésold, 2020a)

2.16. Water Storage Dams

Two water storage dams will be constructed in the two valleys to the east of the Ore Processing Plant. WD1 will be constructed in the valley directly below the plant and will provide water back to the plant. WD 2 will be constructed in the next valley to the east. A series of diversion channels collecting water from the TSF run-off area, will be associated with the two dams. Pumps and diversion channels will be used to transfer water between WD 1 and WD 2.

The source water to fill the two storage dams will be from surface water run-off from both the TSF catchment areas (as diverted by the diversion channels) and from the WRD run-off areas (first rain season). Both water storage dams are located in the southern extent of the TSF drainage area. It is proposed that raw water will be pumped from WD1 to the raw water storage tank (1 000 m^3 capacity) which is located at the Ore Processing Plant. Table 2-8 presents a summary of the key design parameters of the two water storage dams.

Table 2-8: Summary of the design parameters of WD1 and WD2

Parameter	Unit	WD1	WD2
Purpose		Raw water storage dam	Stream diversion/auxiliary water storage
Barrier system		Unlined	Unlined
Wall type		Homogenous earth fill embankment with chimney and strip drains	Homogenous earth fill embankment with chimney and strip drains
Planned start of construction		January 2021	July 2021
Storage capacity	m^3	561 076	357 250
Sized for		Water balance requirements	Part of clean water catchment diversion works
Non-overspill crest elevation	mamsl	1 658	1 663.7
Overflow elevation	mamsl	1 656	1 661.7
Lowest downstream ground elevation	mamsl	1 621.5	1 639.7
Maximum wall height	m	34.5	22
Dam footprint area	m^2	14 250	13 120
Maximum dam width	m	189	133
Maximum dam length	m	163	189
Maximum water depth	m	32.5	17.3
Average crest/wall thickness	m	8	8
Freeboard	m	2	2
Crest length of spillway	m	6	6
Type of overflow/ spillway		Free overflow crump weir	Free overflow crump weir
Maximum water surface	m^2	66 690	50 698
Number of outlet pipes		0	0
Safety features		Fenced-off. Locks on gates.	Fenced-off. Locks on gates.

2.16.1. Embankment

The upstream and downstream slopes of both water storage dams will be 1V:3H (Knight Piésold, 2020a). The zoning of the embankment will be an earth fill dam with a chimney drain. The earth fill will be constructed in maximum 300 mm thick layer to 95% of Standard Proctor maximum dry density at optimum moisture content. A central chimney drain, strip drains under the downstream footprint, and a toe drain will be included in the design to manage seepage and improve stability.

A geonet drainage layer will also be included on the downstream slope below RL 1 648 m, the maximum tailings filling elevation. The function of the geonet is to collect seepage from the TSF, preventing saturation of the downstream slope of the water dam. The geonet will report to the toe drain, which will report to the TSF collector drain along with the strip drains. The upstream slope of the dams will be protected by a 500 mm thick riprap layer underlain be a separation geotextile layer. The downstream slope will be grassed, while a gravel wearing course will be placed on the crest.

2.17. Spillway

The two water storage dams will have identical concrete by wash spillways, located at the left flank of the dam (Knight Piésold, 2020a). Each by wash spillway will comprise of an unlined spillway approach channel, concrete box-cut section through the embankment and a concrete-lined channel transition section. A 6 m wide crump weir will be included in line with the embankment centreline to improve the spillway efficiency, thereby reducing its overall cost. Both dams will have 2 m dry freeboard above full supply level. The zero freeboard maximum capacity of both spillways is 33 m^3/s.

2.18. Birbir Pump Station and Associated Pipeline

It is proposed that a pump station will be constructed on the Birbir River to supply raw water to the Ore Processing Plant during periods of lower than average rainfall (TKGM, 2020). Importantly, water abstracted from the Birbir River will only be used to supplement the plant with process water when the supply of return water from the TSF, water storage dams, pit dewatering, and runoff from the WRDs is insufficient. Water abstracted from the Birbir River will therefore not be required or used in years with above average rainfall.

Water will be transferred at the end of the rain season from the Birbir River to WD1 to bring the dam up to full supply level, which in turn will be sufficient to supply the Ore Processing Plant with water until the next rain season. According the simulations done by Knight Piesold, in an event of two-year abnormal low rain rainfall event (as occurred in 1997/1998), the transfer 350 167 m^3 of water will be required at the end of the rain season. In all events, the transfer of water from the Birbir River will start in September, and for an event similar to the 1997/1998 event, the transfer of water will be completed in mid-November, after a 74-day pumping period. Based on minimum flow conditions in the Birbir River, the abstraction rate will not exceed 0.5% of the river flow.

As shown in Figure 2-21, there is a time lag of the flow in the Birbir River measured against the rainfall in the catchment area (Aira, Gimbi and Alghe stations). As a result, the abstraction of water from the Birbir River at the end of the rain season is likely to have minimal impact on downstream water users.

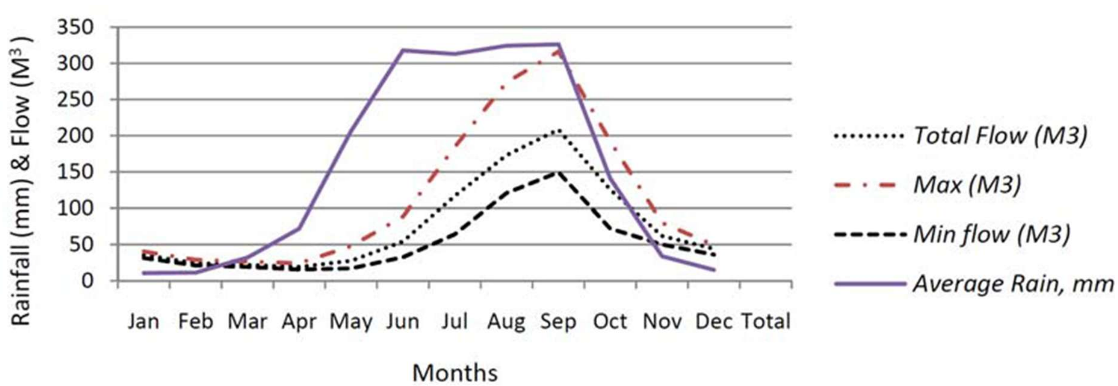


Figure 2-21: Comparison of Birbir River flow (m^3) and average rainfall (mm) (TKGM, 2020)

2.18.1. Pump Station

Abstraction of water from the Birbir River will be done by means of 21 kW Grundfos SL1 type submersible pump, placed within a 2 600 mm diameter steel caisson on the bank of the Birbir River (see Figure 22) (TKGM, 2020). Water will be pumped up to the Ore Processing Plant at total pump head of 340 m (34 bar) using a single KSB Multitec 125 pumps fitted with 280 kW motor. Dual sets of both the Grundfos and KSB pumps will be installed in a duty/standby configuration and rotated during operation of the pumps.

A 98 m^3 steel surge tank (5 m high), located next to the pump station, will be used to balance flow between the river abstraction pump and base pump station. The overflow of the steel surge tank will be directed back into the steel caisson.

The site of the pump station site was selected due to it exposed rock at the riverbank allowing proper foundations for the steel caisson. Hard rock excavation will therefore be required to place the foundation of the steel caisson below minimum water level of the river. Should any blasting be required for the hard rock excavation, covered blasting will be used for the excavation, to prevent the generation of any fly rock during blasting.

Power to the pump station will be supplied by means of a 500 kVA genset. The pumps, switch gear, 500 kVA genset and a 5000 litre bunded diesel storage tank will be containerized within two 6 m (20ft) containers, located next to the steel caisson on an 18 x 25 m^2 hard stand constructed at the riverbank.

As the pumping is to be done continuously over a length period, both the 500 kVA genset generator set and pump station will be manually started and stopped by an operator, which will also act as a security guard. It is foreseen that the pumps and generator will be stopped, inspected, and re-started after a 30 min period, by the maintenance technician at the start of each 8-hour shifts. Fuel consumption for the pumping installation is estimated at 70 ℓ/h, requiring about 1 575 ℓ of diesel over a 22.5 hr operational day. Diesel itself willbe delivered by the mining fleet fuel truck every second day.

2.18.2. Pipeline

The transfer of water from the Birbir River to the Ore Processing Plant will be done via a buried pipeline, which is approximately 8 770 m long (TKGM, 2020). The pipeline itself will be a combination of 200 mm diameter ductile cast iron pipe for the high-pressure section (3 650 m) and 250 mm diameter uPVC pipe for the remainder of the pipeline (5 120 m). The pipeline will be installed in a trench 0.9 m wide and at least 1.3 m deep. Soil cover over the top of pipe will be a minimum of 0.9 m to allow the planting of crops by the community over the pipeline once construction and commissioning of the pipeline is completed. Two isolating valves manhole installation will be required along the pipeline length, at change of pipe pressure class. Air valve installations will be installed in steel cages positioned above ground on pre-cast ring beams.

Construction of the pipeline is to be done in the period following the harvesting in the dry season, allowing the farmers to replant their crops over the pipeline in the next rain season.

The pipeline is to be installed on the edge of the road servitude of the old Keley – Tulu Kapi road for a length of 6 480 m, with the remainder of the pipeline to be installed within the mining licence area ("MLA"). The old Keley-Tulu Kapi road route is preferred over the proposed new pipeline for the following reasons:

- The shorter pipeline length, as the following the new access route will increase the length of pipeline within the road servitude by 2 600 m
- Reduction of the associated environmental impact having a shorter pipeline route
- Better foundation condition at preferred pump station site on the Birbir River
- Reduced pumping pressures to the Ore Processing Plant due to the pipeline profile
- Proximity to the existing Keley–Guji rural power line line crossing the Birbir River, allowing for potential future use of the power line for supply of power to the pump station

It is proposed that boreholes will be drilled at 1 km intervals next to the pipeline route (six in total) and equipped with solar pump installation's as well as a 10 m^3 plastic tank placed on a 1.5-meter-high tank stand. This will be done at the same time as the construction of the pipeline. This will allow the community to collect water from these tanks and by doing so limit the walking to maximum of 500 m to the tanks. The amount of water to be provided to the local community still needs to be determined so as not to negatively impact on groundwater levels, particularly in the dry season.

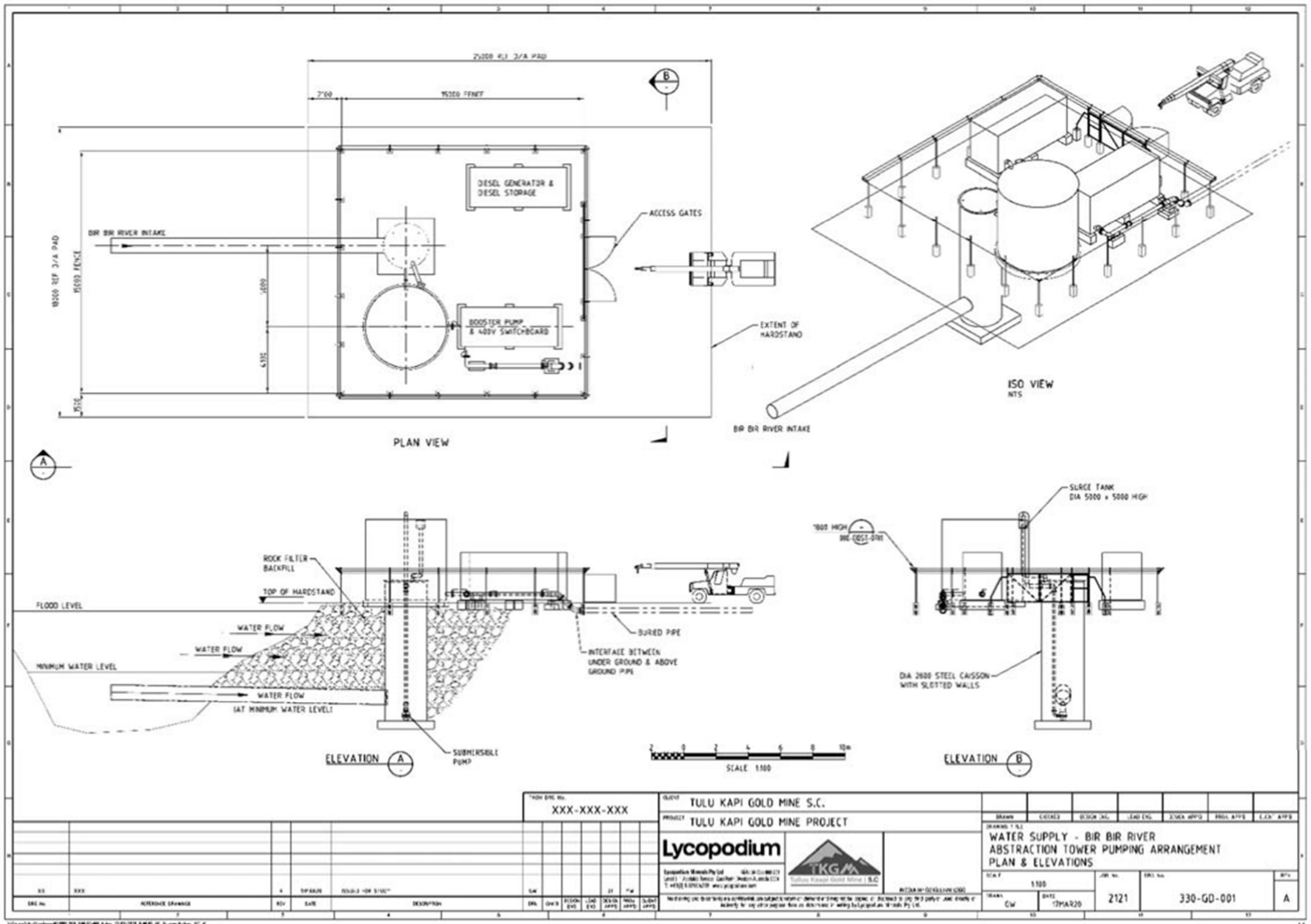


Figure 2-22:Proposed layout of the abstraction tower on the Birbir River

2.19. Ancillary Mine Infrastructure

The ancillary mine infrastructure can be grouped into three (3) separate working areas. This includes:

- **Main Administrative Area:** Comprising the general offices and stores within the main administrative area medium security fence perimeter
- **HME Maintenance Area:** Comprises the HME workshops, stores within the Heavy Mining Equipment ("HME") maintenance area medium security fence perimeter
- **Haul Road A Complex:** Comprises the security camp and other buildings and stores located at the southern end of Haul Road A

A more detailed description of these three areas is provided in the sections to follow.

2.19.1. Main Administrative Area

The proposed the layout of the Main Administrative Area is shown in Figure 2-23. This area will consist of the following main infrastructure:

- Security gate house
- Main administrative building
- Fuel suppliers (Total) office
- Mining contractor (AMS) office
- Metallurgical office
- Plant warehouse and store offices
- Flammable store
- Plant security gate house
- Metallurgical office
- Plant lunchroom and ablutions
- Primary crusher ablutions
- Plant control room
- Plant workshop
- Lime store
- Reagents store
- Acid store

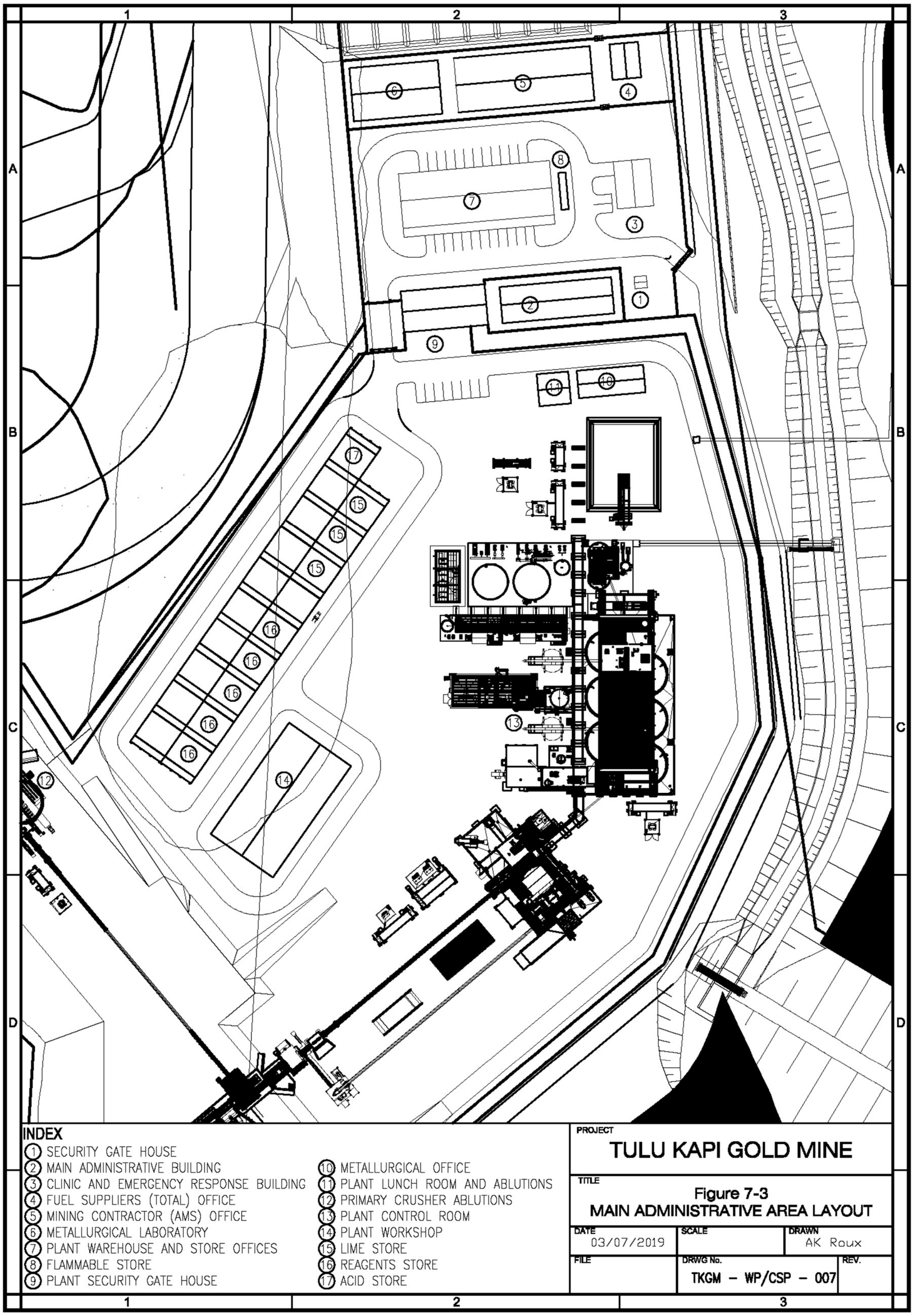


Figure 2-23: Layout of the Main Administrative Area

2.19.2. HME Maintenance Area

The proposed layout of the HME Maintenance Area is shown in Figure 2-24. The HME Maintenance Area will be located to the south of the open pit and will provide all routine and emergency maintenance for the mining fleet (heavy duty vehicles) and light duty vehicles. The HME Maintenance Area will consist of the following main infrastructure:

- Security gate house (17 m^2 prefabricated Building)
- Bulk fuel (diesel) storage and dispensing facility
- Lubricant (oil) storage and dispensing facility
- HME workshop
- Light vehicle workshop
- Hydraulic hose repair shop
- HME stores
- Wash bay
- HME tyre change and repair bay
- HME welding bay
- Oil trap and separator
- Use oil storage area
- HME storage yard/truck assembly area
- Sewerage treatment plant
- Delivery truck parking/holding area

The bulk fuel storage and dispensing facility will house fuel storage tanks and two fuel stations to permit haul trucks to refuel at the start/end of each shift as required. Diesel fuel required will be delivered to site by road tanker to a central fuel storage and distribution system with the capacity to store a 5-week fuel supply on site for all the mine fleet. The storage facilities will be constructed, owned, and operated by an internationally owned, local supplier (likely TOTAL Ethiopia S.C.). The storage facility will be equipped with dedicated firefighting equipment, as well as oil separators.

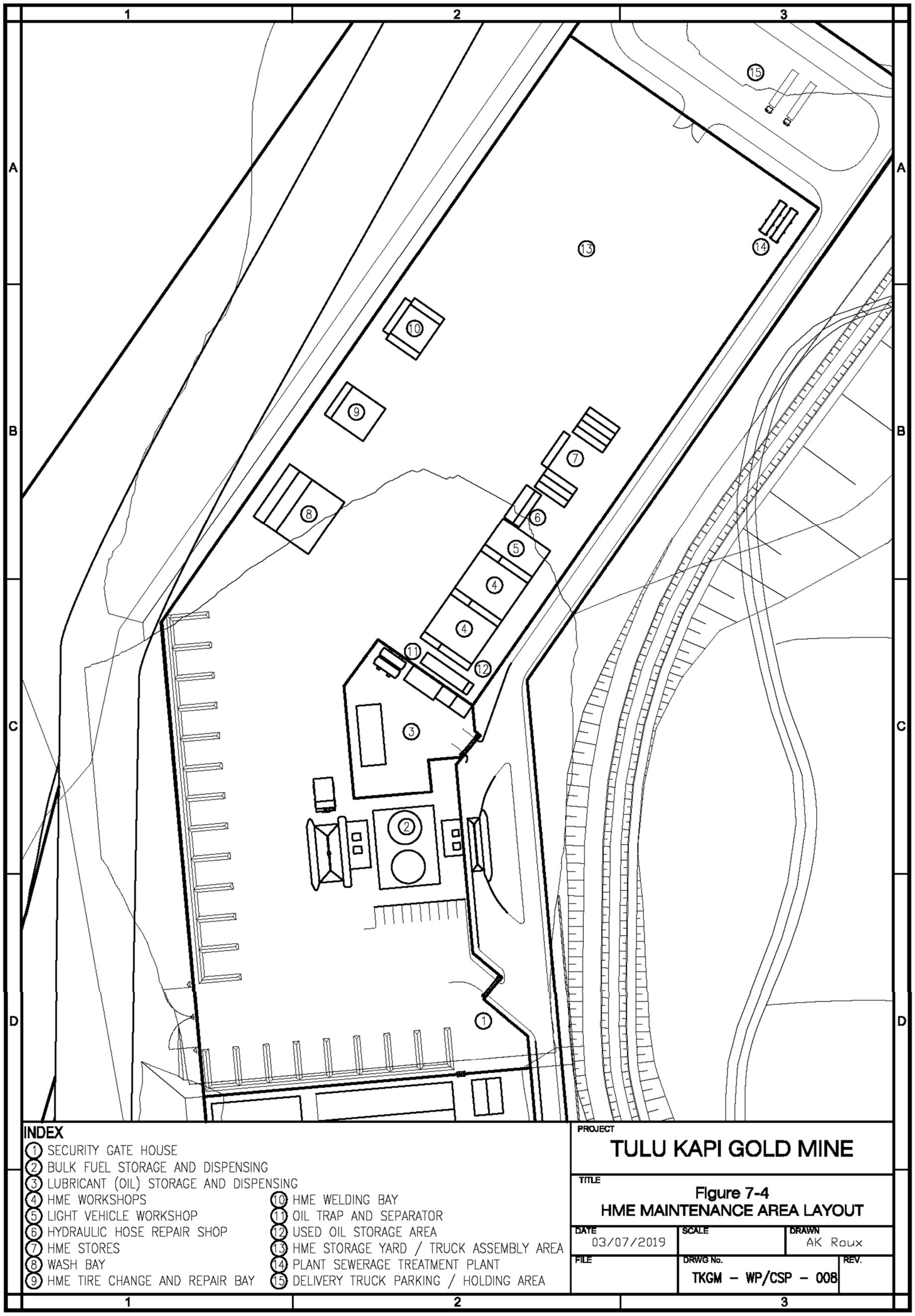


Figure 2-24: Layout of the HME Maintenance Area

2.19.3. Haul Road "A" Complex

The proposed layout of the Haul Road A Complex is shown in Figure 2-25. This area will consist of the following main infrastructure:

- **Security camp**: See Section 2.6.2 for more detailed description of the security camp
- **Emulsion plant:** The emulsion plant will be designed and installed by the explosive supplier. TKGM will be responsible for the design and construction of the foundations as required for the fabricated steel work and the construction of the offices, ablutions, and guard house
- Exploration buildings:
  - Core sheds (8 x 30 m^2 portal frame buildings)
  - Core logging area (1 x 96 m^2 portal frame building)
  - Sample preparation area (22 m x 22 m concrete slab)
  - Sample preparation laboratory (combination of 6- and 12-meter containers)
  - Equipment stores (5 x 40 ft containers)
  - Regional exploration office (1 x 100 m^2 prefabricated building - only to be built after the start-up of mining operations)
- Haul road "A"/emergency landing strip: See Section 2.6 for more detailed description of the emergency landing strip
- Aircraft refuel apron

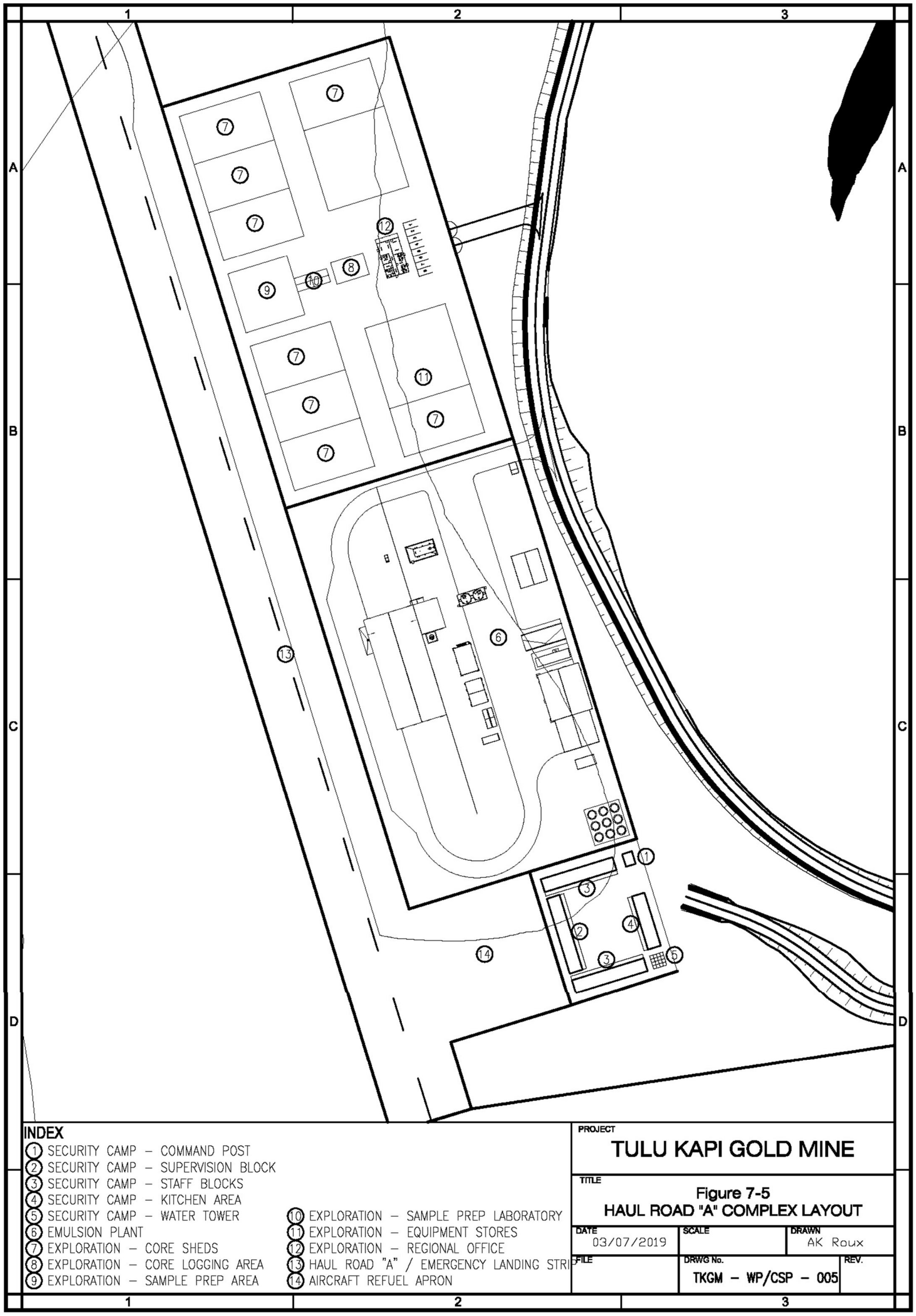


Figure 2-25: Layout of the Haul Road ‘A’ Complex

2.20. Explosives Magazines

The explosives magazines will be located immediately south of the main pit. In accordance with the regulatory requirements the explosive magazines are located at least 500 m from the nearest building. The explosive magazines will be certified containers type magazines supplied by the explosives supplier and installed on precast concrete sleepers. The magazines will be used for the storage of accessories and detonators, and packaged explosives. Lightning protection will be provided for the magazines. The magazines will be fenced by an appropriate security fence and there will be a 2 m high safety bund for the explosion containment in the event of an uncontrolled explosive initiation (Snowden, 2015).

2.21. Accommodation

2.21.1. Construction Camp

Prior to the start of construction, the existing exploration camp will be upgraded to provide accommodation for up to 150 persons. This will be done by converting the existing core sheds to temporary accommodation units and providing suitable ablution and shower blocks. Importantly, the construction camp will comply the requirements of the IFC and EBRD's Public Guidance Note on Workers' Accommodation: Processes and Standards. The construction camp will be demolished at the end of the construction phase as it is situated within the footprint of the main pit and will therefore need to be removed prior to the start of the operational phase.

2.21.2. Permanent Camp

The permanent camp (also referred to as the Tulu Kapi Village) will be constructed to the south-east of the Ore Processing Plant, between the two water storage dams. The camp will be constructed to house senior and junior staff members, comprising a combination of both expatriates and Ethiopian nationals who do not reside in the vicinity of the Project site. The accommodation capacity of the camp will be for approximately 257 rooms or 313 residents. Each room will be approximately 10.63 m^2 including an allowance for the share of the ablution block.

As the permanent camp accommodation units come online, they will be used to house the bulk of the construction workforce. These units will be doubled up during the construction phase to cope with the workforce numbers. At peak of construction, overflow from the construction camp and permanent camp will be accommodated in a tented camp located at the existing exploration camp. Short time visitors will be accommodated offsite in hotels at nearby towns like Gimbi.

The proposed layout of the camp is shown in Figure 2-26. The camp will comprise the following:

- Senior management accommodation units (9 x 36 m^2 prefabricated building), with each unit designed to accommodate 1 person each
- Supervisory staff accommodation blocks (7 x 129 m^2 prefabricated building), with each block designed to accommodate 16 people each during construction and 8 during operations
- General staff accommodation blocks (24 x 145 m^2 prefabricated building), with each block designed to accommodate 16 people during construction and 8 during operations
- Kitchen and dining hall building (1 x 826 m^2 prefabricated building)
- Gate house with turnstiles (1 x 17 m^2 prefabricated building)
- Camp reception and administration block (1 x 117 m^2 prefabricated building)
- Laundry block (1 x 145 m^2 prefabricated building)
- Main recreation block with television viewing area and tuck shop (1 x 326 m^2 prefabricated building)
- Secondary recreation block with gymnasium (1 x 141 m^2 prefabricated building)
- Site management services operations room (1 x 82 m^2 prefabricated building)
- Camp waste management/sorting area (concrete/brickwork installation)
- Site services maintenance workshop (containerized) with storage containers
- Power generators and substation
- Water treatment plant
- Sewer treatment plant
- Carpark

2.21.3. Security Camp

A 30-man security camp will be constructed during the first phase of construction. The camp will be positioned close to the main access gate, within the Haul Road A Complex (see Figure 2-25). This camp will be used to accommodate the security team which will be mobilised at the start of construction. The security team will reside in the exploration camp during the construction of the security camp.

The security camp will comprise the following:

- A command post (1 x 17 m^2 prefabricated building)
- Supervisory staff accommodation block (1 x 133 m^2 prefabricated building) able to accommodate 6 people
- Security staff accommodation blocks (2 x 127 m^2 prefabricated building), with each block able to accommodate 12 people
- Kitchen and dining area
- Press panel steel water tank (70 m^3) on a 20 m high tank stand to supply potable water to both the permanent and security camps
- Standby diesel generators until the commissioning of permanent electricity supply infrastructure
- Temporary water treatment facilities able to treat raw water extracted from the existing borehole at the exploration camp

Septic tank to collect sewerage from the security camp (and rest of Haul Road A Complex) and a sewer pipeline to transport the sewerage to the sewerage treatment

- plant at the Ore Processing Plant

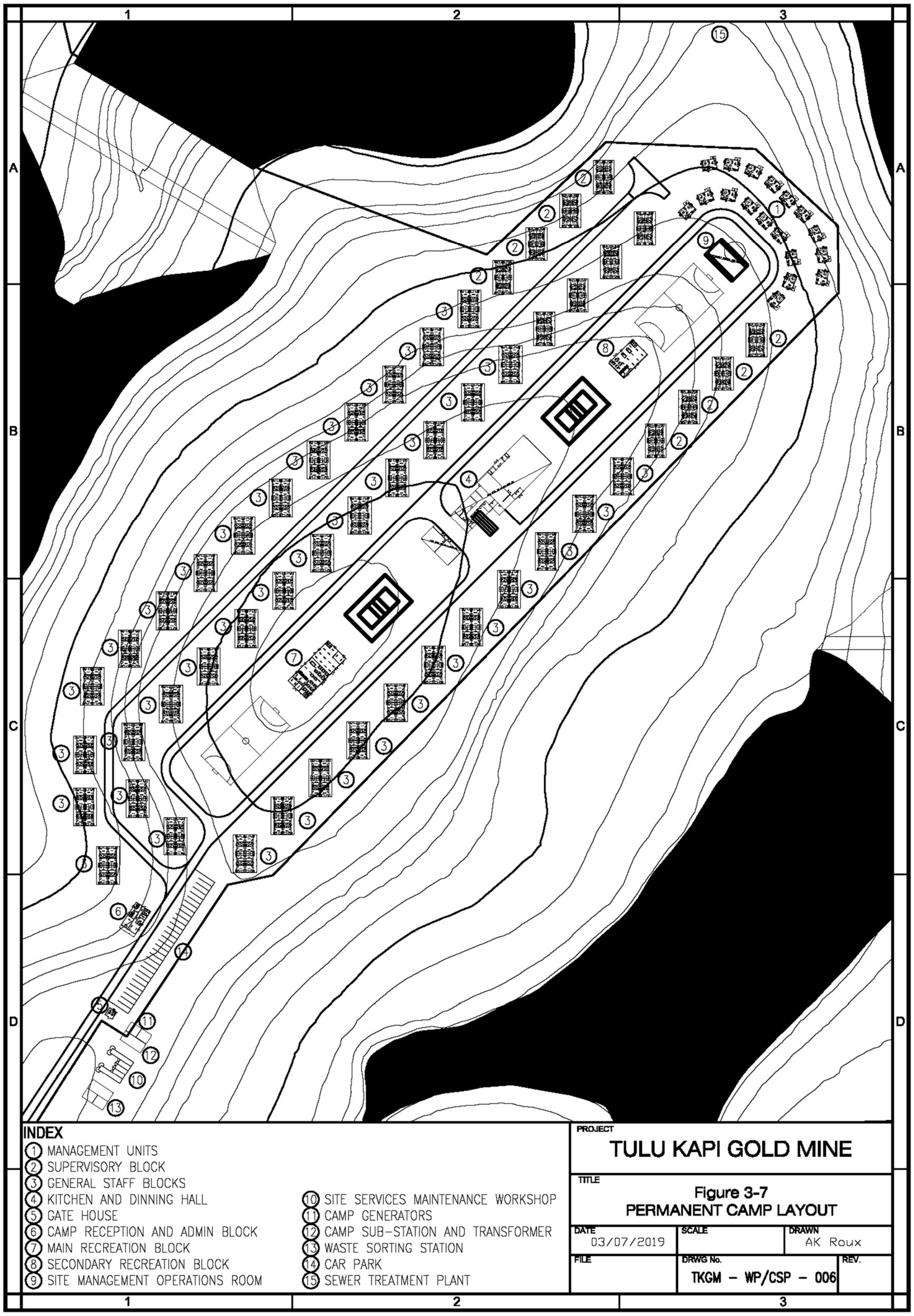


Figure 2-26: Proposed layout of the permanent camp

2.22. Access and Haul Roads

2.22.1. Access Roads outside the Mining Licence Area

There is an existing road which connects the village of Keley to the Project site. This road is however unsuitable for use for the Project and in order to minimise the impact of traffic on the local community, three major roads that lie outside the MLA will be constructed during the development of TKGP (Figure 2-27).

These roads are:

1) **New Keley to Tulu Kapi access road:** This road is designed to become the primary access road for the TKGP as it connects with the existing main road to Addis Ababa just to the east of the town of Keley. The road will be constructed as an unpaved, 6 m wide, Design Class DS6, with a maximum road grade of 12% in accordance with the Ethiopian Roads Authority's Design Manual for Low Volume Roads. The total length of this road will be 14.2 km
2) **New Southern Bypass road:** This road is designed to divert public traffic, primarily from the village of Guji, around the MLA. The road will be constructed as an unpaved, 3 m wide, Design Class DS9 road for Mountainous Terrain in accordance with the Ethiopian Roads Authority's Design Manual for Low Volume Roads. This road will replace the portion of existing Guji to Gengi public road which passes through the MLA, which will be closed to the public when mining operations commence. The total length of this road will be 4 km
3) **New North-Western Bypass road:** This road is designed to divert public traffic around the northern edge of the MLA once mining operations are underway. The road will connect the existing Tulu Kapi to Keley access road with the village of Guji. This road is planned to be constructed just before operations commence. The total length of this road will be 1 km

Under an agreement with the Ministry of Finance and Economic Co-operation of the Federal Democratic Republic of Ethiopia ("MOFEC"), all of these roads, including a new road bridge crossing the Birbir River, will be designed and constructed by the Ethiopian Roads Authority.

During the construction phase, traffic to the Project site will comprise containerised materials as well as general traffic, such as buses for transporting workers, mine camp supplies, and so on. During the operational phase, it is estimated that the total traffic load will include three truck and trailer fuel trucks per day, buses at shift change daily and 1.5 containers per day for supplies, plus light vehicles.

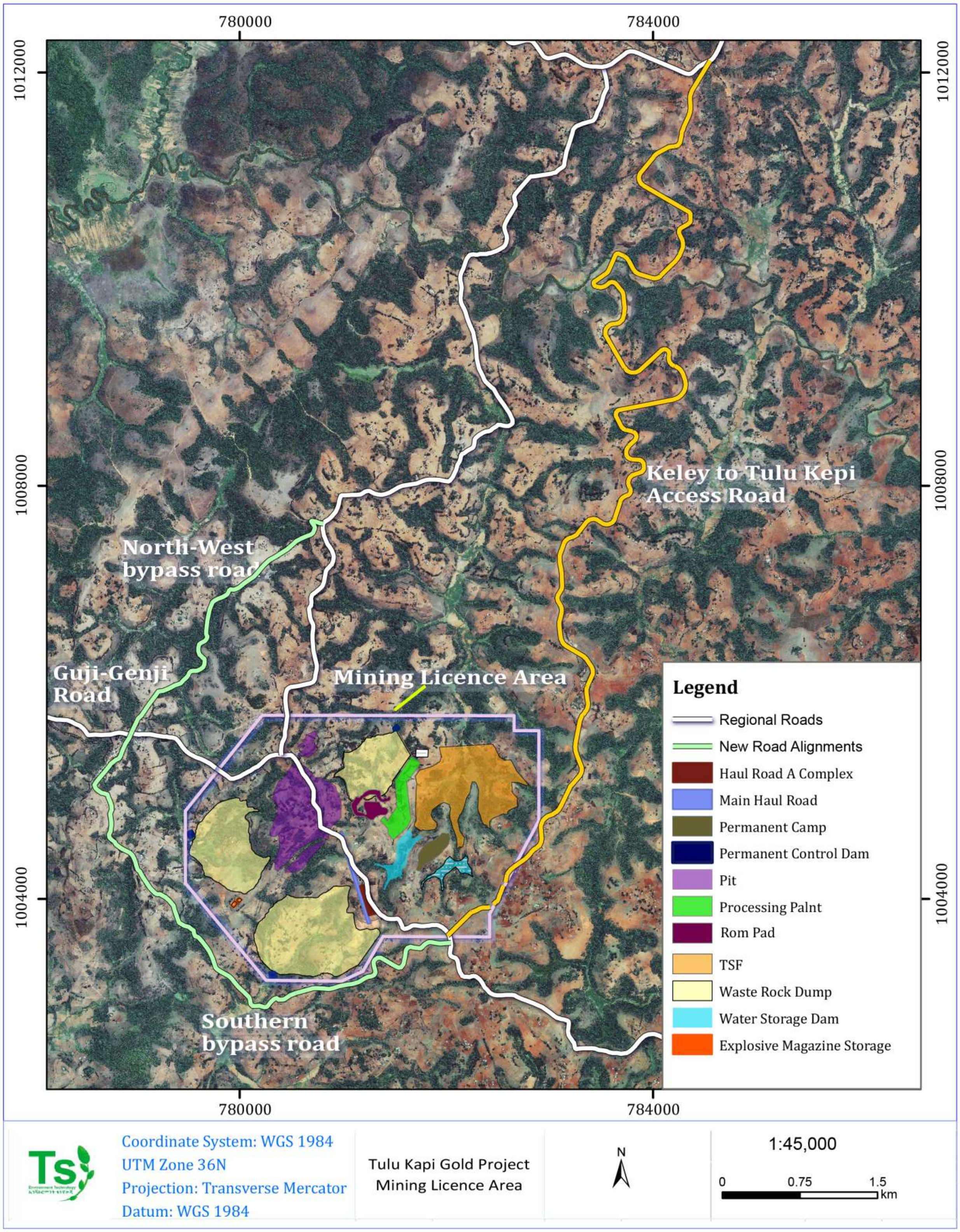


Figure 2-27: Proposed access roads and off-site infrastructure

2.22.2. Access Roads within the Mining Licence Area

Planned access roads inside the MLA include the following:

- An extension of the Keley-Tulu Kapi access road to the Ore Processing Plant and mine services area: This road will be designed as unpaved 6 m wide Design Class DS6 road
- A branch road from the Keley-Tulu Kapi access road to the permanent camp: This road will be designed as an unpaved 6 m wide Design Class DS6 road
- An access road to the Tulu Kapi substation and TSF: This road will be designed as an unpaved 6 m wide Design Class DS6 road
- A service road to WD2 via the dam wall of WD1: This road will be designed as a 4 m wide graded road following the natural contours just downhill of the diversion channel between WD1 and WD2
- Mine haul roads from the pit to the ROM stockpile, primary crusher, WRDs and TSF: These roads will designed with a 25 m width to support two-way mine haul truck traffic and 1 m high and 3.5 m wide safety berms made of either compacted soil or mine waste rock

The haul roads will be designed and constructed by the mining team, using the mining fleet during the development of the mine pit. The remaining of the roads will be constructed by the bulk earthworks contractor during the construction phase.

Within the permanent and security camps, limited internal roads with enough parking will be established. A network of pedestrian walkways will be established within these camps interlinking all the relevant buildings and facilities. All surfaces will be porous.

1.1.1.1 Airstrip (Haul Road A)

A 920 m long landing strip located adjacent to the security camp close to the mine access gate. This 30-meter- wide landing strip forms part of the mine haul roads, namely Haul Road A (see Figure 2-25). As the landing strip will only be used in emergencies using a 'Cessna C208B Grand Caravan' type aircraft, it will not be formally registered as a landing strip.

2.22.3. Supporting Infrastructure

In addition to the infrastructure, the following support infrastructure will be required for the effective operation of the TKGP.

2.22.3.1. Electricity Supply

Under an agreement with the MOFEC, the Ethiopian Electric Power Corporation (“EEPCo”) will be responsible for the supply of bulk electricity to the TKGP and the extension of the EEPCo electricity supply grid from their Gimbi 132 kV substation to the Project site.

The full scope of the grid connection from Gimbi 132 kV substation to the TKGP includes the following:

- Extension of the existing 132 kV bus bar in Gimbi substation by a single bay
- Installation at Gimbi substation of 132 kV switchgear, to control and protect the new 132 kV transmission line to the TKGP
- Construction of approximately 47 km of 132 kV, 15 MVA minimum rated, transmission line on steel, lattice towers, from the Gimbi substation to the EEPCo’s new 132/33kV Tulu Kapi substation
- The construction of the EEPCo’s new Tulu Kapi substation (2x20/25MVA 132/33kV). This substation will be arranged normally for one transformer to feed the TKGP and one transformer to feed the local
- community, but with a sectioned 33kV switchboard arranged to allow outage of one transformer whilst the remaining transformer feeds TKGP plus the local community load
- The construction of a new 33 kV electricity transmission line from the EEPCo’s new 132/33kV Tulu Kapi substation to TKGP’s Medium Voltage switch room

The integrity of the power supply was reviewed during the final study by Lycopodium (2017). The results of this study concluded the following:

- There is sufficient capacity in the local 132 kV grid for accommodating the revised demand requirements of 9.4 MW for the TKGP
- There is no need for any additional reactive compensation measures to accommodate the starting of the larger 6 MW SAG mill. The voltage drop during motor starting is within the acceptable limits on the 33 kV
- and 132 kV systems
- Additional harmonic filtering on the 33 kV system is not required for the 6 MW SAG mill variable speed drive (“VSD”) provided the harmonics are managed at the drive level
- The capacity of the 15 MVA substation at Tulu Kapi is sufficient for the increased demand requirement and there is no need to scale up the costs of this substation for the increased load requirement
- Power factor correction is required in the Ore Processing Plant

Electricity reticulation for medium voltage, low voltage and control voltage will be undertaken at 33/11 kV, 400 V and 110 V, respectively. The estimated power demand for the different working areas within the MLA are shown in Table 10 below:

Table 2-9: Estimated electricity consumption and demand of different areas (Lycopodium, 2017)

Area or equipment	Connected (kW)	Maximum demand (kW)	Average load (kW)	Average annual (MWh)
Overhead power lines (including)				
Tailings return water, raw water, seepage dam, boreholes, plant infrastructure, mine services, explosives, and Permanent Camp etc.	1 543	1 076	947	8 299
Sub-total (overhead powerlines)	***1 543***	***1 076***	***947***	***8 299***
Main 33/11 kV switchboard				
Feed preparation	405	289	204	1 783
Grinding and CIL	2 262	1 239	1 119	9 806
Tailings and services	1 740	954	847	7 418
SAG mill	6 122	5 816	3 320	29 083
Power factor correction	0	0	0	0
Sub-total (main switchboard)	***10 530***	***8 298***	***5 490***	***48 090***
Total TKGP	**12 073**	**9 374**	**6 437**	**56 389**

2.22.3.2. Water Supply

Two containerised potable water treatment plants with a 3 m^3/h capacity will be used to provide potable water to the TKGP. These treatment plants will be fed from the raw water storage tank at the Ore Processing Plant. Each water treatment plant will comprise a 50 m^3 capacity above-ground potable water storage tank (2h hr storage capacity), filtration, reverse osmosis, and a chemical dosing system. Potable water will be distributed to the mine site facilities, including the workshop, administration building, clinic, and warehouse, as well as the security camp and permanent camp by means of underground high-density polyethylene piping.

During the construction phase, water will initially be abstracted from the local river and existing boreholes within the main pit area. This water will be used for construction activities, such as earthworks and gravel road surfacing, as well potable water supply.

2.22.3.3. Sewage Treatment

There will be two 30 m^3/h capacity modular sewage treatment plants at the TKGP. Having two independent sewage treatment plants was selected over a central sewage treatment plant as it alleviates the need for costly, long, and troublesome raw sewage pipelines to a central facility. One plant will be located at the HME Maintenance Area to service the Ore Processing Plant and the security camp. The other plant will be located at the permanent camp.

Both plants will utilise biological treatment technologies. This technology was selected over others due to its ability to withstand fluctuating loads that normally take place during shift change over. The Ore Processing Plant will employ simple, reliable, and well proven trickling filter technology, while the permanent camp will have a biogas sewage treatment system installed. A network of underground polyvinyl chloride piping will be installed for the collection and transport of sewage to the sewage treatment plants.

2.22.3.4. Waste Management

The domestic waste will be collected from various points at the TKGP and transported to a central area. An incinerator will be purchased for the incineration of the domestic waste. Incineration temperatures shall be high enough to prevent the release of carcinogens through the incineration of plastic. The incinerator will likely be located in the south-east corner of the site of the Ore Processing Plant.

Where feasible, construction rubble, non-hazardous industrial waste, and domestic waste will be recycled and re-used in an approved manner.

Due to the remoteness of the Project site, an onsite waste disposal facility will need to be constructed for the safe disposal of non-hazardous and hazardous wastes. The facility will likely be located on or near either the North WRD or the TSF. Additional studies are however required prior to the construction of this facility. This includes a preliminary geotechnical investigation for site selection, geotechnical investigation for detailed design, conceptual design, and detailed design. It is recommended that once the location and concept design of the facility has been finalised, that this ESIA report is updated to include a more detailed assessment of the potential impacts associated with the facility. It is proposed that the hazardous wastes will be landfilled within separate cells with a barrier that is appropriate for the type of waste that is being landfilled. The proposed onsitewaste disposal facility will be developed and operated in accordance with the relevant Ethiopian legislation and international standard practice.

Table 2.10 presents a preliminary waste management framework/plan for the management domestic and hazardous waste that will be generated by the TKGP.

Table 2-10: The waste management framework/plan

Waste stream	Area generated	Volumes	Preliminary classification	Preferable Disposal Option	Storage and disposal
Batteries e.g. lead acid batteries from Forklifts	Vehicles and Workshops	Low	Hazardous	Treatment	Collected by a private licensed service provider for draining and treatment of sulphuric acid and Recycling of lead.
Blasting residues	Various places in mining area	Low	Hazardous	Hazardous landfill	Onsite waste disposal facility.
Clinical waste	Clinic	Low	Hazardous	Incineration	Onsite incineration with bottom ash landfilled in onsite waste disposal facility.
Conveyor belting (Flammable).	Conveyance, mining construction and operational phases	Low	Hazardous	Treatment	Onsite waste disposal Facility.
Packaging used for transport and storage of cyanide briquettes	Process	Low	Hazardous	Treatment	Decontamination of packaging used for transport and storage of cyanide briquettes in the CIL bounded area. Onsite incineration of the decontaminated packaging once it has air dried. Disposal of incineration ash in the onsite waste disposal facility.
Electrical and Electronic waste.	Electrical workshop and mine	Low	Hazardous	Recycle/ Treatment	Waste to be recycled or returned to supplier where possible.
General office, including paper/plastics, uncontaminated containers and putrescible wastes.	Offices, canteen, residential area, guest house, sport facilities	Low	Non-hazardous	Non-hazardous landfill or on-site mass burn incinerator	Reuse, recycling on site as a priority. Non-hazardous on-site landfilling or off-site non-hazardous landfilling, where recycling is not possible. Alternatively, a small mass burn incinerator with controlled point source emissions may be used.

Waste stream	Area generated	Volumes	Preliminary classification	Preferable Disposal Option	Storage and disposal
Laboratory wastes and raw materials containers.	Laboratory	Low	Hazardous	Treatment/ incineration	Onsite incineration with bottom ash landfilled in the onsite waste disposal facility.
Metals, ferrous and non- ferrous (including cabling and non-flammable conveyor belting).	Various place in mining area	Low	Non-hazardous	Recycle	Scrap metal should be recycled as ferrous and non-ferrous metals by local scrap metal merchants.
Oily rags, filters, containers, cotton and other similar wastes.	Workshops and mine	Low	Hazardous	Recycle/ treatment	Reprocessed and reused or apply for approval to incinerate. Used as a secondary fuel source in furnaces. As a last option this should be landfilled in onsite waste disposal facility.
Overburden	Constructio n phase	Medium	Non-hazardous	Reuse	Stored on site for rehabilitation purposes
Petroleum waste	Workshops	Low	Hazardous	Recycle/ treatment	Recycle or apply for approval to incinerate.
Sewage and sewage sludge	Conservanc y tanks	Low	Hazardous	Treatment/ landfill	Sewage to be treated at one of the two onsite sewage treatment plants.
					Sewage sludge to be disposed of at the onsite waste disposal facility.
Tyres and rubber hoses etc.	Various places in mining area	Low	Non-Hazardous	Recycle/ landfill/ incinerate	Recycling of rubber type wastes is preferable or apply for approval to incinerate. Otherwise, disposal by burying in a separate landfill site or encapsulated in waste rock.
Wood pallets and off cuts	Various place in mining area	Low	Non-hazardous	Reuse/ recycle	Wood waste should be reused/recycled onsite or made available to the local community for use.

2.22.3.5. Security

The Ore Processing Plant, permanent camp, and explosives magazines will be surrounded by a 2.4 m security fence to prevent unauthorised entry. The boundary fence will be demarcated by a clear/open area that will be drivable track if possible, with signage on boundary that is both informative and provides warnings related to site access. Access to these areas will be by means of a main access gate manned 24 hours per day by security guards, ensuring restricted access to the premises. Guards shall patrol the perimeter fences 24 hours a day and there will be CCTV coverage (further inside) from towers. Additional fencing will be provided at key areas, such as the administration building, fuel storage, gold room area, transformers, substations and so on, to provide additional security.

TKGM will be responsible for providing all security services at the mine. Contractors will be responsible for providing secure storage for goods and equipment and for ensuring that they are used properly. Contractors will also be responsible for supplying transport for their personnel not living in camp from their local area to the Project site and back before and after their working day.

2.22.3.6. Fire fighting

The Ore Processing Plant will be equipped with an electric and diesel-powered fire water pumping system. The fire water system will consist of a buried fire water loop and hydrant system at the plant and ancillary buildings. Hose cabinets will be placed at the fire hydrant locations and the system supplemented with portable fire extinguishers placed within the process facilities. The raw water storage tank at the Ore Processing Plant will also provide capacity for the fire water system. This will be achieved by raising the raw water outlet nozzle to ensure that the minimum fire water volume of 350 m^3 is always available.

In addition to the fire water distribution system, all other buildings will be supplied with portable fire extinguishers. Portable fire extinguishers shall also be provided with mining equipment and at any strategic locations deemed necessary to maintain a safe working environment at the TKGP.

A fire truck will be available at the TKGP to attend to any grass or other fires not contained through the use of local fire extinguishers or in close proximity to installed fire water ring mains.

2.22.3.7. Catering

Contractors will provide a detailed scheduled of those entitled to full messing and accommodation. One meal a day will be provided by TKGM to employees of the contractors working at the Project site not entitled to messing and accommodation. TKGM will provide safe drinking water to all personnel while working at the Project site.

2.23. Labour Requirements

To effectively manage the operations at the TKGP, the labour schedule was drawn up by assuming four main areas notably management, technical services, operations, and maintenance. These three main areas were in turn broken down into respective disciplines. Table 2.11 provides a summary of the total labour complement for each department[3]. Provision was made within the schedule for additional labour to cover for annual leave, sick leave and absenteeism (”ASLA”).

Table 2-11: Total manning complement for the TKGP

Department	Years															
	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Management	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Technical services	7	24	25	26	28	34	34	35	36	32	26	24	24	3	2	0
Operations	47	90	142	162	184	201	201	203	197	135	96	74	61	17	17	12
Maintenance	0	47	71	83	83	83	89	89	89	71	59	47	40	19	19	12
Total labour	**56**	**163**	**239**	**272**	**296**	**320**	**320**	**329**	**324**	**240**	**183**	**147**	**127**	**41**	**41**	**24**

The mining operation at the TKGP will operate 3 shifts per day of 8 hours duration each, 7 days per week. Expatriates will be employed to fill nominated roles for the LOM, and will comprise approximately 28% of the total workforce complement. Other expatriates will be employed for no longer than 3 years to fill specific roles after which Ethiopian nationals who have gained the experience will take over. All other roles in the operation will be filled by Ethiopians. The intention is to prioritise the employment of suitable local staff. Where these are not available recruitment from the remainder of the country will take place. Corporate headquarters will be established in Addis Ababa.

A Local Procurement Plan is currently under development. In short, TKGM will develop food supply chains that assure internal quality and quantity requirements are met. TKGM will encourage local procurement opportunities through co-operatives that complement the food supply chain, with an objective of increasing local procurement annually throughout the life of mine.

Food being bought in Ghimbi is typically sourced from Addis Ababa. The supplier does not currently meet quantity and quality needs despite increasing advance times of food orders. Local farmers are subsistence farmers and will take a long time to adapt to farming for profit should they so choose.

To manage TKGM's expectations and the expectations of outsiders, TKGM will begin with a guaranteed supply chain and work to improve local procurement over time. This will be done in consultation with stakeholders and specialists as they develop livelihood restoration programs, to determine if there is an opportunity for the program to assist in meeting this objective.

A Recruitment, Training and Local Employment Plan is currently under development in consultation with operations and social aspects. TKGM intends to train and hire as many local employees as possible and this is demonstrated through the housing policy (accommodation is available for 250 people) but expect far more employees during construction and operation. As work will be through contractors, TKGM will work with them to implement a local employment policy that is agreeable.

Gender Equity in Employment and Recruitment

TKGM has proposed a Gender and Community Development Plan that will identify opportunities and prioritize employment for women. Women from local communities will be provided opportunities for skills development, education, and training through a variety of programs to support the project and to increase opportunities for women to diversify their contributions to the community.

In many communities affected by extractive industries, gender bias exists in the distribution of risks and benefits. Risks, such as environmental damage and social harm, fall more heavily on women, while benefits, such as employment and compensation, accrue mostly to men. Therefore, a better understanding of these gendered impacts associated with extractive industries is needed to create and share information on ways to minimize risks and maximize community empowerment, as well as to ensure that extractive industries project development plans include gendered perspectives. This includes opportunities for women to create their own businesses, education, and skills training and employment. Gender specific opportunities are intended to address the historically disproportionate burden of unemployment on women, and empower female decision making and influence concerning household income.

On-going priority identification is recommended to appropriately address the challenges to achieving gender equality and community empowerment. Though community priorities may be aligned in part with many of those set by national policies and strategies, the latter may be only partially indicative of the former. Through stakeholder assessment, collaboration and decision-making, specific community priorities and their various weights can be articulated and addressed. Women in the Project area specifically emphasized the need for women's employment opportunities as well as employment opportunities for their family members, and their desire for assistance in establishing a collective shop offering staples at reasonable prices.

The Project will address beneficial opportunities for women and implement actions to prevent a working environment that is hostile towards women. Actions recommended to help mitigate gender-specific negative impacts and encourage female employment include:

- Special prioritization of opportunities for Project affected women and female-headed households through discussion with local community members and organizations
- Staggered hours to support female employees' additional responsibilities such as daily chores and child rearing, as well as establish a community-approved/culturally appropriate alternative childcare provider(s)
- Equitable and appropriate wage compensation between female and male employees performing equivalent work
- Zero tolerance policies for sexual harassment and intimidation, and must be enforced in all sectors of the mining workplace
- Training programs must focus recruitment efforts on women and create female and

family-friendly educational and employment environments

Site Manning

TKGM intends to minimise the number of construction workers/employees at the Project site; all manning lists shall be approved by TKGM in advance. All employees shall have current medical certificates of good health; criminal record checks and is covered by an employment guarantee or is covered by fidelity insurance provided by the employer.

Contractors and consultants shall provide TKGM with a detailed schedule of all expatriates. TKGM shall assist contractors in obtaining the necessary visa and permits, but having the correct paperwork is the responsibility of the individual and the contractor. All labour shall be locally hired from an approved list provided by TKGM. Exceptions to this will be approved by TKGM in advance. Decisions by contractors on working public holidays, overtime and the like will be approved by TKGM's human resources department in advance. Contractors and their employees will abide by TKGM 's site policies, procedures, and rules.

TKGM reserves the right to remove any employee or contractor from the Project site that:

- Fails to adhere to the policies, procedures, and rules
- Fails to respect local cultural customs and practices
- Commits criminal acts in contravention of the laws of Federal Democratic Republic of Ethiopia (“FDRE”)
- Fragrantly ignores Health and Safety standards
- Brings TKGM into disrepute through their actions

Project Management

The Engineering, Procurement, and Construction Management (“EPCM”) contractor, in association with TKGM’s Project team, is responsible for the design, procurement, installation and commissioning of all civil works, mechanical equipment, structural steelwork, piping, electrics and instrumentation, buildings, information technology and communications, high voltage (6.6 kV) reticulation and equipment and low voltage reticulation and equipment. Management of interfaces and battery limits with TKGM on earthworks, high voltage (132 kV) and the mine camp construction shall be formal and proactive.

All contractors will agree to TKGM 's anti-bribery and corruption policy and will procure adherence by their staff and sub-contractors. All contractors must have the appropriate insurance cover in place as designated by government policies as relates to undertaking construction work in Ethiopia. These must include but not be limited to:

- Medical insurance for all employees
- Accident insurance including all vehicles
- Public liability insurance

All contractors must have in place all relevant permits to enable them to work in construction in Ethiopia. Materials, good and services will, wherever possible on a like-for-like basis and at comparable cost, be obtained from Ethiopian registered companies and persons.

Health and Safety

TKGM is committed to the wellbeing and safety of its own employees and employees of any contractors working on the Project. As the basis of this, all workers must undertake an induction before commencement of their activities. In this, TKGM’s Health and Safety Policy and standard operating procedures (“SOPs”) will be explained. All workers will need to affirm that these are understood and will be complied with.

TKGM will have qualified health and safety professionals at the work site to assess the standard of compliance and mentor the contractor and its employees. TKGM will strive for continuous improvement and will take the path of education and training to achieve this.

TKGM will provide a site clinic staffed by qualified medical practitioners’ that will be able to undertake first responder medical care.

A site committee involving all sections of management and the workforce will be formed to review compliance with the health and safety regime. This committee will also undertake the duties of a crisis management team to evaluate the response to unplanned events and initiate the appropriate action. This committee will be chaired by TKGM's Health, Safety, Environment and Security Manager or his designate.

Training

TKGM's approach to training is to provide a fit for purpose workforce that allows a seamless, low risk transition into operations and a continuous assessment and up skilling to maintain the integrity of this workforce throughout the life of the mine. To achieve this goal TKGM will:

- Assess the gap between existing skill levels available in country against the skill levels required by the operation
- Tailor recruitment towards the levels closest to that requirement
- Develop the appropriate training regimes to fill those gaps where they exist and enable shift profiling
- Include in these training regimes the actual SOPs, work packages and health and safety procedures specific to the running of the Project's operations
- Develop on-the-job training to complete any formal training, identify leadership potential and feedback into previous stages

A subcontractor will conduct a review of policies and procedures. It will make recommendations on the requisite health and safety (H&S) training, production of policies and procedures and any other training and training programmes that it deems appropriate. TKGM will employ a subcontractor to establish and equip the trainers for all induction and TKGM training. TKGM will decide subsequently how much of the policies and procedures and other training will be provided under contract.

TKGM's policy is generally to train people on the job using an appropriately skilled TKGM expatriate employee to develop the practical skills.

2.24. Identification of Alternatives

The Project design team has, with the input of the ESIA team, considered a few location, activity, technology, and/or temporal alternatives in ensuring that negative impacts are minimised, and positive impacts maximised. These are described below.

Mining Method

Two mining methods were considered by Wardell Armstrong International[4], namely open pit mining and underground mining. Open pit mining was selected and this choice of mining method for the Project is based on the depth of the ore body. The depth of the ore body is 100 – 300 m below the ground surface, and thus this is best suited to mining from the surface – i.e. open pit mining.

Transportation

The decision to transport gold from the site with a helicopter was taken to ensure that the church located adjacent to the proposed airstrip location was not impacted by the Project.

Ore Processing Plant

The design of the processing plant is based on a few key considerations and alternatives, the objective being that the plant is efficient and will meet international construction and environmental standards. The key design and location considerations were as follows:

- Technologically proven process design
- Reliability of the equipment during operation
- Efficient process design for maximum recovery of gold
- Ease of maintenance
- Geology and topography

- Cost-effective technology
- Power and fuel efficiency
- Compliance with environmental, health and safety standards

Site Layout

The placement of infrastructure such as the TSF, WRDs, Ore Processing Plant, roads, workshops, and offices considered financial, environmental, and social considerations – including cultural heritage to develop a site layout with the fewest impacts as possible. For example, the site layout is designed to minimize the displacement of some of the churches in Bikiltu Ankore and the school to the extent possible.

WRD Location

Wardell Armstrong International undertook a high-level study aimed at selecting the most preferred location for the WRDs from an economic, environmental, and social perspective considering cultural heritage. The positioning of the WRDs were updated/changed to further reduce the environmental and social impact of the footprint thereof as well as reduce overall costing. Three WRDs are proposed in the current design.

TSF Location

Golder's engineering team carried out a TSF site selection study during the pre-feasibility study on a 5 m contour map available for the MLA. Five potential TSF sites were identified. The selection of a preferred site for the construction of the proposed TSF has included detailed consideration of several options which have been evaluated against a set of site selection criteria. The site selection criteria, options considered and the selection of a preferred site for the establishment of the TSF are described in below.

- Site Selection Criteria: The selection of a preferred site for the establishment of a TSF includes consideration of a wide range of technical and environmental issues. The information used to support the
- Evaluation of environmental issues in the site selection process has been sourced from specialist investigation of the Project area by specialist scientists as part of the ESIA process. The ESIA process requires that options be considered for the location of key project infrastructure. Specialist studies carried out during the ESIA process have included evaluation of the candidate sites. The selection of candidate sites site for the development of the TSF has been based on:
    - Proximity to the centre of gravity of the proposed mining and processing operations
    - The topography of the areas available for development
    - Ensuring that potential sites have the capacity to store the anticipated volume of tailings
    - Ensuring that areas of existing or potential mining activity are avoided
    - Avoidance of significant surface water drainage systems
    - The avoidance of existing infrastructure
- Description and preliminary assessment of candidate sites:
    - TSF Option 1: This option may encroach on the site of the Ore Processing Plant, but it is expected that this impact could be mitigated with the use of engineered berms. The proposed site layout would impact on three drainage lines. Option 1 has the lowest volume of material required for construction of the TSF starter embankment
    - TSF Option 2: This option covers the site of the Ore Processing Plant, as well as most of the proposed primary crusher site. This option also potentially encroaches on the proposed portal to the future underground workings and has therefore been excluded from further consideration
    - TSF Option 3: This option encroaches on the site of the Ore Processing Plant, well as some of the primary crusher site and the underground mine portal and has therefore also been excluded from further consideration

- TSF Option 4: This option is located away from all the proposed mine infrastructure. Most of the proposed site is however located outside of the currently approved MLA. Based on this as well as the fact that it has the largest impact on the surface water environment this site has also been excluded from further consideration
- TSF Option 5: This option does not interfere with the Ore Processing Plant or primary crusher, and the potential impact to the mine portal area can be mitigated with an engineered berm. The site has the smallest footprint area and is in the smallest catchment of all the sites. The site is also located down grade of the proposed waste dump and would capture runoff from the waste dump. The proposed site has the second smallest starter embankment.
- Based upon the description of the sites and the associated assessment of their suitability it was determined that only TSF Options 1 and 5 were suitable for development as tailings disposal facilities.

- **Selection of the preferred site:** Based on more detailed consideration of TSF Options 1 and 5 and discussions with the Project team it was decided that Option 1 was the preferred site for the development of the TSF. This decision was based on:
  - The proximity of TSF Option 5 to the open pit and the possibility that mineralisation associated with that pit may extend to the TSF footprint area
  - The location of TSF Option 1 down grade and immediately adjacent to the Ore Processing Plant, which would enable it to serve as a contaminated water containment system to the plant and surrounding areas
  - The lower overall height of TSF Option 1

Land Clearance Scheduling Alternatives

According to the Project schedule, TKGM have options for clearing of vegetation for the open pit and infrastructure within the MLA. To reduce further disruption to farming activities in the Project affected area, it is proposed that clearing of land will take place after the harvest season to the extent possible. Land clearance will take place during the dry season to limit the potential for erosion causing downstream impacts.

Access Road

Two options for the TKGP's access road from Keley to the Project site were evaluated:

- Option 1 - upgrade the existing public road to minimum secondary road standards
- Option 2 - construct a new access road to the east of the existing access road that also will meet the minimum secondary road standards

The existing road alignment, noted as Option 1, is 9 314m in length, but does not extend to the Ore Processing Plant. The new access road alignment, noted as Option 2, is 14 885m to the Ore Processing Plant.

The relative strengths and weaknesses of the two options are presented in Table 2.12.

Table 2-12: Relative strengths and weaknesses of alternative road options

	Strengths	Weaknesses
Option 1 – Upgrade the existing access road	• The Ethiopian Government decided to take on the upgrading of the existing road. The road has been widened to 6 m width up to the Birbir River Bridge. This bridge and the road to the Project site will still be upgraded by Government. There are also plans to potentially make this a tar/asphalt road • The existing road will benefit the existing communities located along the alignment with an improved access road • The Option 1 existing road length (9.3 km but does not go to the mine site) is shorter (as currently shown) than Option 2 (14.9 km to the mine site)	• Option 1 will result in the relocation of 81 homes/buildings (with an average 5.5 people per home) as part of the upgraded existing access road alignment • Heavy trucks will be hauling in the components of the Ore Processing Plant and supplies through the relatively populated alignment, so there is a higher risk of accidents and speed will have to be monitored closely • The road alignments that approach both sides of the river are very steep to create an all-weather access road. This potentially may be a fatal flaw for this alignment due to the construction cost to create a road and bridge that meets the Project's objectives

Option 2 – Construct a New Access Road	• Since the Option 2 new road alignment is less populated, the risk of a mine related traffic accident is lower than for Option 1 Option 2 would create access to farmers along its alignment that currently do not have road access near their farms • The construction of the Option 2 river approach alignment is not as steep as those in Option 1 and therefore the construction cost to meet the road standards, to create an all-weather access road, and minimise the construction cost for the bridge and related abutments earthwork will be less than for Option 1 • Option 2 extends all the way to the mine operation without having to use the proposed southern road bypass as would Option 1	• Option 2 may result in the relocation of approximately 12 structures (homes/buildings) as part of the new road alignment construction • Option 2 is located outside the MLA • The Option 2 new road alignment will not benefit the local population to the same degree as Option 1's upgrading of the existing road alignment • Option 2 will result in permanent loss of agricultural land due to construction of the new road • Option 1, the existing road upgrade, would still likely require some minimal upgrade initially to repair any damage caused by mine traffic up to the time of opening Option 2. • The construction of a new bridge over the Birbir River and an upgrade to the community bridge will result in increased cost when compared with Option 1

Considering the relative benefits presented above, the preferred alternative is to pursue Option 2.

Water Sourcing

Based on the planning parameters and assumptions, water modelling indicates that for a surface water harvesting solution only, under average conditions, there is a significant risk that sufficient raw water would not be available to commission and operate the process plant through the first year of operation. To reduce the risk of water shortfalls, TKGM will source water from the Birbir River at a location ~ 5 km to the north of the Project site (~ 8 km by road) – see Section 2.5.8. The catchment area reporting to the proposed abstraction location is approximately 890 km^2.

The process water shortfall risk can be significantly reduced by incorporating abstraction from the Birbir River at a rate greater than 30 ℓ/s. Based on a qualitative assessment of risk and pipe costs, a pumping rate from the Birbir River of 55 ℓ/s is considered an appropriate compromise.

Aggregates for Road Building

TKGM will source aggregates for construction materials (including roads) from waste rock cleared from the main pit. Alternative borrow-pits were also considered prior to selecting the option to use "waste" material.

Go-No-Go Project Alternative

The current land use consists of limited agricultural and woodlot operations. The no-project option will result in the continuation of such land uses. Although economically viable, the continuation of subsistence agriculture will not provide the level of short-term and long-term economic diversification and growth to the area that the TKGP would offer. The economic benefits of the Project potentially include:

- Increased employment opportunities for local people in the area
- Improved livelihood opportunities
- Greater development and associated socio-economic development of the Tulu Kapi area and Ethiopia as a whole

In addition, the gold reserves would remain unutilised and there would be little or no economic growth in the region and country which may reduce the attractiveness of Ethiopia as an investment destination. If the Project were not to go ahead there would be no royalties/revenues paid to the Government of Ethiopia.

3. LEGAL, REGULATORY AND POLICY FRAMEWORK

This section presents a summary of the Ethiopian legislative and administrative framework for, including international obligations Ethiopia has signed up to, and the implications of this in terms the ESIA associated with the proposed TKGM Project.

In addition to the applicable regulations and norms of the government of Ethiopia, the proposed Project has committed to comply with the requirements of the IFC, European Bank for Reconstruction and Development ("EBRD") or Equator Principal Financial Institutions.

3.1. Institution and Administrative Framework

The 1995 Federal Democratic Republic of Ethiopian Constitution (Federal Constitution) recognises dual layers of government. The Constitution allocates powers and functions to the Federal Government and Regional States (Article 50). There are ten Regional States[1] and two Chartered Cities (Addis Ababa and Dire Dawa). Each Regional State is further sub-divided into Zones, Woredas (districts) and Kebeles (neighbourhoods).

The powers and functions of the Federal Government and Regional States are set out in the Federal Constitution. The Federal Government has exclusive power on matters within its jurisdiction2, whereas the states exercise power over matters not expressly allocated to the Federal Government (either alone or concurrently with the Regional States)3. The Regional States are mandated to formulate and execute a state constitution, laws and other policies, the levying and collecting of taxes and duties on revenue sources as well as the administration of land and natural resources4.Federal Government

Proclamation No. 1097/2018 establishes and defines the powers and duties of the Executive Organs of Ethiopia. The key Executive Organs relevant to the project are discussed below.

- Environmental Protection Authority Environment, Forest, and Climate Change Commission (EFCCC) is the former Ministry of Environment, Forest, and Climate Change, which pursuant to Proclamation No. 1097/2018 is now directly accountable to the Prime Minister5. The EFCCC is mandated to coordinate activities to ensure the realisation of the environmental objectives in the Constitution and the Environmental Policy. In particular, the EFCCC is mandated to establish a system of environmental impact assessment or strategic environmental assessment and establish a system for evaluation and decision making prior to approval. It is also mandated to formulate and coordinate policies, laws, standards, and guidelines along with strategies and programs related to environmental management and to follow up on the implementation of these.
- Ministry of Mines and Petroleum (MoMP) is responsible for the promotion and regulation of the mineral and petroleum resources in the country. The MoMP is entrusted with formulating the legal framework for the development of these resources. The MoMP is also mandated to ensure reliable and accessible geophysical data on the mineral, petroleum, and natural gas resources of the country, promote the mineral and petroleum potentials of the country, negotiate and issue exploration and mining licenses to investors, and ensure investors operate in accordance with the relevant licenses/ agreements and meet their financial obligations. It is the responsibility of the MoMP to create conditions for the employment of local communities in places where mining operations and explorations of petroleum and natural gas are conducted.
- Ministry of Water, Irrigation and Energy (MoWIE) is responsible for management of water resources and electricity. The role of the Ministry is to promote the development of water resources and electricity, investigate the potential of the country's water resources, participate in

[1] The ten regional states are Tigray, Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, Southern Nations Nationalities and Peoples, Gambela, Harari, and Sidama.

[2] Constitution, Art. 51 These include: preparation and implementation of economic, social and development policies, foreign investment policies, interstate commerce and foreign trade. In addition, federal jurisdiction lies on administration of the national bank, issuing currencies, borrowing money, controlling foreign exchange and circulation of money.

[3] Constitution, Art 52(1).

[4] Constitution, Art 52(2)

[5] Proclamation No.1097/2018, Art. 33/3.

the negotiation of treaties pertaining to trans boundary water resources, prescribe water quality standards, coordinate the implementation of projects financed by foreign assistance and loans, and negotiate and issue permits and ensure that works are undertaken in accordance with these permits.

- The Basin Development Authority is responsible for issuing water use and water works permit.[6]
- Ministry of Revenue is responsible for regulating and enforcing the tax regime of the country. The Ministry is required to establish a system to facilitate the tax collection and ensure the proper implementation of tax related incentives. The applicable tax in relation to mining is regulated under a separate section of the Federal Income Tax Proclamation No.989/2016. The business tax levied on mining is lower than the tax rate normally set for other investments. A licensee or contractor in the mining industry is required to pay 25% business income tax[7].

Other relevant Federal Ministries and government authorities include:

- Ministry of Finance
- Ministry of Urban Development and Construction
- Ministry of Agriculture
- Ministry of Trade and Industry
- Ministry of Transport
- Ministry of Health
- Ministry of Labour and Social Affairs
- Ministry of Culture and Tourism
- Ministry of Women, Children and Youth

3.2. Regional Government

The administrative and regional states are constitutionally endowed with equivalent rights and powers. The Constitution provides that regional states have legislative, executive, and judicial powers[8], with regions allowed to legislate their own laws in relation to land and natural resources in accordance with the applicable federal laws.

3.3. National Legislative Framework

The ESIA for the TKGP was carried out within the framework of Ethiopian environmental legislation and guidelines. Ethiopia adopted its Constitution in 1995, which provides the basic and comprehensive principles and guidelines for environmental protection and management in the country. The FDRE divides management responsibilities between the federal government and regional states. Federal Proclamations 33/1992, 41/1993 and 4/1995 define the duties and responsibilities of the regional states to include planning, directing, and developing social and economic development programs as well as protection of natural resources. Accordingly, the legislative frameworks applicable to the proposed project are relevant proclamations, national environmental guidelines and regulations issued by the FDRE and that of the Oromia Regional Government and are outlined below.

No	Policy/ Proclamation/Regulation	Brief Description	Applicability to this Project
1	The constitution of the Federal Democratic Republic of Ethiopia (1995)	The constitution is the supreme law of the land and it was adopted by Ethiopia in 1995 and provides guiding principles for environmental protection and management thereof in Ethiopia. The concept of sustainable development and environmental rights are enshrined in Article 43, 44 and 92 of the constitution. Article 43 defines the people's right to improved living standards and	A number of proclamations and supporting regulations contain provisions for the protection and management of the environment and put into effect the principles of the constitution and the environmental policy. Details of the impacts induced by this particular business operation of the company and their mitigation measures plan

6 Article 5(7) of Definition of Power, Duty, and Organization of the Basin Development Authority Regulation No.441/2018.
7 Proclamation No. 989/2016, Art. 37/3/
8 Constitution, Art. 50& 52/2/

		sustainable development. Similarly, Article 44states that all persons in Ethiopia have the right to clean and healthy environment. Article 92 states that the design and implementation of projects in Ethiopia shall not damage or destroy the environment and that government and citizens have the duty to protect the environment.	provided in the subsequent topics.
2	Environmental Policy of Ethiopia (1997)	The Environmental policy of Ethiopia was approved the councils of Ministers in April 1997 and contains elements that emphasise the importance of the mainstreaming socio-environmental dimensions in development programs and projects. The goal of environmental policy of Ethiopia is to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of resources and the environment as a whole to meet the needs of the present generation without compromising the ability of future generation to meet their own needs.	Like the Constitution, the Environmental Policy of Ethiopia also makes provisions for social aspects and provides for the protection of both natural and human environments. It also recognizes the importance of public participation in proposed developments. The requirements included in this policy have been considered in the study.
3	Environmental Impact Assessment Proclamation (No. 299/2002)	The Environmental Impact Assessment (EIA) Proclamation makes EIA a mandatory requirement for the implementation of major development projects, programs and plans in Ethiopia. The proclamation is a tool for harmonizing and integrating environmental, cultural, and social considerations into decision making processes in a manner that promote sustainable development.	The Proclamation states that EIA studies need to include measures to eliminate, minimize or mitigate negative impacts, a contingency in cases of incidents and procedures of self-auditing and monitoring during the implementation. Hence, TJGM should conduct an ESIA study prior the commencement of the Gas gathering and treatment project. The ESIA study shall include section mentioning various environmental management plans.
4	Environmental pollution Control Proclamation (No. 300/2002)	This is another environmental legislation enacted in 2002 by Federal Democratic Republic of Ethiopia. The proclamation advocates a "Polluter pays"	Activities associated with the company's business operation in the country i.e. business operations both by TKGM that have

		principle and the licencing authority has the right to close or relocate any initiative if the activity being carried out poses a risk to human health and the environment.	potential to pollute the environment shall be identified during the ESIA study.
5	Prevention of Industrial pollution control council of Ministers Regulation (159/2008)	This regulation is directed to industry and in particular to factories. However, some section such as the need to emergence response systems and the needs to monitoring of environmental safety relate to this particular business operation of AOE.	Business operation of TKGM needs to have emergence preparedness plan in its EMP program. Moreover, social and environmental monitoring system should be included in the EMP report.
6	Water Resources Management Proclamation (No. 197/2000)	The purpose of this proclamation is to ensure that the water resources (both surface and ground water) of Ethiopia are protected and utilized for the highest social and economic benefits of the country's people. It addresses the requirement for environmental conservation and water resource protection measures to be incorporated into water resource planning and project development.	According to the proclamation, no person is allowed to supply whether for his own use or for another without having obtained a permit from the supervising body. Hence, TKGM need to apply to respective the water licensing authority to obtain the required water permit/license necessary for the successful implementation of the proposed. The proclamation determines waste as any harmful matter introduced, released or discharged into any water body in any liquid or solid or gaseous form. Moreover, the proclamation defines polluted water as sewage and industrial effluents including toxic water.
7	Mining Operations Proclamation No. 678/2010	The Mining Operations Proclamation No. 678/2010, which came into effect in 2010, revised mining laws in Ethiopia. This Proclamation (and amendments) lays down the regulatory framework for mining operations in Ethiopia. It defines the principles of sound development of the mining sector and defines the criteria for eligibility for mining rights.	The Proclamation requires an application for a mining license to be accompanied by an EIA report (Part 3, Section 26). There are several other provisions in the Proclamation that need to be considered when undertaking the EIA for the Project, as summarized below: • The Proclamation requires licensees to take proper precautions not to interfere with other legitimate occupants of the license area, the land covered by a lease and

			adjacent land (Part 3, Section 34). • The Proclamation promotes preferential employment of Ethiopian nationals, as well as preferential procurement of goods and services from Ethiopia (Part 3, Section 34). An application for a mining license must be accompanied by proposals to achieve this. • The Proclamation requires removal of constructions in the license area and lease area upon termination of the license or relinquishment of the license area (Part 3, Section 34). The licensee is required to allocate funds for rehabilitation of environmental impacts (Part 7, Section 60). • Land tenure and compensation for disturbance of surface rights are dealt with in Part 6 of the Proclamation. A holder of a mining license must obtain the written consent of the owners or occupants of the land to use the land. Compensation must be paid, and in the event the applicant and landowner cannot agree the amount of compensation, the decision will be determined by the licensing authority pursuant to Section 59. • The Proclamation requires the licensee to participate in community development activities for people within the license area and shall allocate funds to cover these activities (Part 7, Section 60). TKGM required to meet these condition..
9	Water Resource Management Regulation (No. 115/2005)	The Objective of this Regulation to provide detailed provisions for the effective implementation of its parent	As discussed above, TKGM need to apply to respective the water licensing authority to

		legislation, the Water Resource Management Proclamation. This Regulation is mainly the further elaboration of the aforementioned Water Resource Management Proclamation providing in detail the requirements for the issuance of permits for different use of water, construction works, waste water discharges as well as providing the conditions for the issuance, renewal, revocation etc. of such permits.	obtain the required water permit/license necessary for the successful implementation of the proposed project. The proclamation determines waste as any harmful matter introduced, released or discharged into any water body in any liquid or solid or gaseous form. Moreover, the proclamation defines polluted water as sewage and industrial effluents including toxic water. TKGM shall comply this legal requirement when using water from the project area and must ensure waste water treated to meet applicable local requirements.
10	Proclamation 513/2007Solid waste management	Solid waste management- Preparation of solid waste management action plan by urban local governments and promoting community participation to prevent adverse impacts	TKGM shall have a waste management plan in place in its all operations
11	Proclamation No. 541/2007	This Proclamation shall have the following major objectives: 1/ to conserve, manage, develop and properly utilize the wildlife resources of Ethiopia; 2/ to create conditions necessary for discharging government obligations assumed under treaties regarding the conservation, development, and utilization of wildlife; 3/ to promote wildlife-based tourism and to encourage private investment.	TKGM shall have a biodiversity management plan in place in its all operations
12	Public Health Proclamation 200/2000	Treatment and control of liquid wastes; monitoring of treatment and disposal facilities; handling, disposal and control of industrial and domestic wastes; potable water quality monitoring; occupational health, safety and use of machinery; industrial hygiene; availability of toilet facilities and shower rooms; notification of communicable diseases. The proclamation also stipulates provisions for	TKGM is required in cooperate and implement the provisions of this Proclamation; to conduct potable water quality monitoring; adherence to health and safety, good housekeeping and waste management practice.

		offences committed by violating the low and entails serious penalties punishable with fine and/or up to rigorous imprisonment (see Article 20: Penalty).	
13	Proc. No. 1156/2019 Labour proculamation	This proclamation requires that the employer take the necessary measures to adequately safeguard the health and safety of their workers. In this proclamation, the employer-worker relation relations are governed by the basic principles of rights and obligations with goal to enable workers and employers to maintain industrial peace and work in the spirit of harmony and cooperation.	Conditions with regard to workers' safety and provisions of personal protective equipment (PPE) included in the EMP.
14	Proclamation No.455/2005 Land use	Expropriation of Landholdings for Public Purposes and Payment of Compensation Proclamation) needs to be followed. This includes compensation requirements and entitlements for affected peoples. It outlines the required procedures and time limits. It is noted that the power to expropriate landholdings belongs to a Woreda (district government) or urban administration for a development project, and the bidder will need to liaise with these authorities during the land acquisition process.	TKGM is required to comply proclamation No 455/2005 if land accusation is required for the proposed mining and associated infrastructure project Emphasis-Expropriation of Landholdings for Public Purposes and Payment of Compensation Proclamation) needs to be followed. This includes compensation requirements and entitlements for affected peoples. It outlines the required procedures and time limits. It is noted that the power to expropriate landholdings belongs to a Woreda (district government) or urban administration for a development project, and the bidder will need to liaise with these authorities during the land acquisition process.
15	Expropriation of Land Holdings for Public Purposes, Payments of Compensation and Resettlement Proclamation" (Proclamation No. 1161/2019).	This new legislation was issued to rectify and fill gaps envisaged in the former legislation i.e., "Legislation on Expropriation of Land and Compensation Proclamation No. 455/2005", and to include other provisions to make the system of expropriation of land holdings and payment of	TKGM is required to comply proclamation No 1161/2019 if land accusation is required for the proposed mining and associated infrastructure project

		compensation more comprehensive and effective. The legislation, among other things, states that compensation and resettlement assistance compensation for the expropriated land shall sustainably restore and improve the livelihood of displaced people.	
16	Environmental Standards for Industrial pollution control (Air quality, water resources and Noise emissions)	The Federal Democratic Republic of Ethiopia has developed a list of environmental standards for the purpose of preventing significant industrial pollution such as pollution limits to emissions to atmosphere, water resources and noise emissions	Effluent discharges in Ethiopia are controlled by the environmental standards for industrial pollution control. Standards are specified for a number of industrial sectors. Ethiopian environmental standards, however, have not been endorsed and have very limited legal enforcement power. However regional and federal governments have the responsibility to control effluents. Ethiopia is signatory to a number of international conventions and agreements relating to, environmental management, waste and energy and hence Multinational business companies usually adopt internationally recognized and accepted environmental standards like the ISO effluent standards, Kiyoto Protocol and the Cartagena Protocol on Biosafety to the Convention on Biological Diversity.
19	Waste Handling and Disposal Guideline, 1997	Guideline meant to help industry and local authorities handle medical waste situation at the local level.	The guideline states the measures the processes that has to be taken in the case of medical waste disposal
20	Guideline for Environmental Management Plan (draft),2004	The guideline outlines the necessary measures for preparation of an Environmental Management Plan (EMP) for proposed developments in Ethiopia and the institutional arrangements for implementation of EMPs.	-

Table 3-1: Additional Permits and Approvals

Proclamation	Requirement
Ethiopian Building Proclamation No.624/2009	Approvals are required for building construction works, the approvals are in three stages: planning consent, construction permit and use permit.
Radiation and Nuclear Protection Proclamation No.1025/2017	Approvals are required to import, transport, export or dispose of a radiation source. Note: this is likely to be required due to the use of density meters in the process plant.
National Intelligence and Security Service Re-establishment Proclamation No.804/2013	Permits are required to import, use, and dispose of explosives.
Water Resources Management Proclamation No. 197/2000	Permits are required for water use, discharge to water, and works within a watercourse. This Proclamation is implemented by the Council of Ministers Ethiopian Water Resources Management Regulations No. 115/2005 detailing the information to be included within the relevant water permits application/s.
Environmental Pollution Control Proclamation 300/2002	Permits are required to be obtained for the management of certain types of wastes. This Proclamation is implemented by the Prevention of Industrial Pollution Council of Ministers Regulation No. 159/2009, pursuant to which a license is required to verify effluents are within the relevant standards. This Regulation also sets out the requirement to prepare and implement an emergency response system and implement an internal environmental monitoring system.
Forest Development, Conservation and Utilisation Proclamation No. 1065/2018	Establishes the rights of developers in private forest, community forest, association forest or state forests.
Solid Waste Management Proclamation No. 513/2007	Permits are required for the collection, transportation, use or disposal of solid waste.
Research and Conservation of Cultural Heritage Proclamation No. 209/2000	Written approval needs to be obtained to remove any cultural heritage.
Proclamation 1161/2019: Expropriation of Land Holdings for Public Purposes, Payment of Compensation and Resettlement	This Proclamation applies to Government expropriation of land for public purposes. The Proclamation sets out the process for expropriation, identifying the landholder and issuing the expropriation order, as well as determining the compensation and valuation of property. The Proclamation is implemented by the Expropriation and Valuation, Compensation and Resettlement Regulation No. 472/2020, which provides details of the approach to payment of compensation and restoration of livelihoods.

3.4. International Treaties and Agreements

Treaties are international agreements that are generally intended to be implemented through enactment and enforcement of laws at national levels. There are three types of treaties relevant to environment and sustainable development covered this EIA. These are:

- environmental treaties
- the 24 human rights treaties of United Nations (“UN”) Treaty Collection (Human Rights, Chapter 4, http://treaties.un.org); and
- the workplace treaties of relevance to the environmental and social aspects of the project that take the form of International Labour Organization (“ILO”) Conventions (http://www.ilo.org/dyn/normlex/en/)

The status of ratification by Ethiopia of these treaties is given in the tables below.

Table 3-2: Key International Environmental Treaties

Grouping	Convention: Full title of treaty	Convention: Date of entry into force	Status in Ethiopia: Action type	Status in Ethiopia: Ethiopia participation date
Climate change and protection of the ozone layer	United Nations Framework Convention on Climate Change	09/05/1992	Ratification	05/04/1994
	Kyoto Protocol to the United Nations Framework Convention on Climate Change	11/12/1997	Accession	14/04/2005
	Doha Amendment to the Kyoto Protocol	08/12/2012	Acceptance	26/06/2015
	Paris Agreement	12/12/2015	Ratification	09/03/2017
	Vienna Convention for the Protection of the Ozone Layer	22/03/1985	Accession	11/10/1994
	Montreal Protocol on Substances that Deplete the Ozone Layer	16/09/1987	Accession	11/10/1994
	Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	29/06/1990	Ratification	25/11/2009
	Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	25/11/1992	Ratification	25/11/2009
	Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	17/09/1997	Ratification	25/11/2009
	Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	03/12/1999	Ratification	25/11/2009
	Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	15/10/2016	Ratification	05/07/2019
Hazardous chemicals, waste and pollution	Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal	22/03/1989	Accession	12/04/2000
	Amendment to the Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal	22/09/1995	Ratification	08/10/2003
	Basel Protocol on Liability and Compensation for Damage Resulting from Trans boundary Movements of Hazardous Wastes and their Disposal	10/12/1999	Accession	08/10/2003
	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	10/09/1998	Accession	09/01/2003
	Stockholm Convention on Persistent Organic Pollutants	22/05/2001	Ratification	09/01/2003
	Minamata Convention on Mercury	10/10/2013	Signature	-
Biodiversity and the protection of plants and animals	Convention on Biological Diversity	05/06/1992	Ratification	05/04/1994
	Cartagena Protocol on Biosafety to the Convention on Biological Diversity	29/01/2000	Ratification	09/10/2003
	Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity	29/10/2010	Accession	16/11/2012
	Lusaka Agreement on Co-operative Enforcement Operations Directed at Illegal Trade in Wild Fauna and Flora	08/09/1994	Signature	01/02/1995
Desertification	United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	14/10/1994	Ratification	27/06/1997

Table 3-3: UN Treaties on Human Rights

Convention		Status in Ethiopia	
Full title of treaty	Date of entry into force	Action type	Ethiopia participation date
Convention on the Prevention and Punishment of the Crime of Genocide	09/12/1948	Ratification	01/07/1949
International Convention on the Elimination of All Forms of Racial Discrimination	07/03/1966	Accession	23/06/1976
International Covenant on Economic, Social and Cultural Rights	16/12/1966	Accession	11/06/1993
International Covenant on Civil and Political Rights	16/12/1966	Accession	11/06/1993
International Convention on the Suppression and Punishment of the Crime of Apartheid	30/11/1973	Accession	19/09/1978
Convention on the Elimination of All Forms of Discrimination against Women	18/12/1979	Ratification	10/09/1981
Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment	10/12/1984	Accession	14/03/1994
International Convention against Apartheid in Sports	10/12/1985	Ratification	22/07/1987
Convention on the Rights of the Child	20/11/1989	Accession	14/05/1991
Amendment to article 43 (2) of the Convention on the Rights of the Child	12/12/1995	Acceptance	15/04/1998
Optional Protocol to the Convention on the Rights of the Child on the involvement of children in armed conflict	25/05/2000	Ratification	14/05/2014
Optional Protocol to the Convention on the Rights of the Child on the Sale of Children, Child Prostitution and Child Pornography	25/05/2000	Accession	25/03/2014
Convention on the Rights of Persons with Disabilities	13/12/2006	Ratification	07/07/2010

Table 3-4: ILO Conventions of Potential Relevance to the EIA

Grouping	Conventions: Full title of treaty	Conventions: Date of entry into force	Ethiopia participation date
Freedom of association, collective bargaining, and industrial relations	Freedom of Association and Protection of the Right to Organise Convention (No. 87)	04/07/1950	04/06/1963
	Right to Organise and Collective Bargaining Convention (No. 98)	18/07/1951	04/06/1963
Forced labour	Forced Labour Convention, (No. 29)	01/05/1932	02/10/2003
	Abolition of Forced Labour Convention (No. 105)	17/01/1959	24/03/1999
Elimination of child labour and protection of children	Minimum Age Convention, 1973 (No. 138)	19/06/1976	27/05/1999
	Worst Forms of Child Labour Convention, 1999 (No. 182)	19/11/2000	02/10/2003
Equality of opportunity and treatment	Equal Remuneration Convention, 1951 (No 100)	23/05/1953	24/03/1999
	Discrimination (Employment and Occupation) Convention, 1958 (No. 111)	15/06/1960	11/06/1966
Industrial Relations	Weekly Rest (Industry) Convention, 1921, (No. 14)	19/06/1923	28/01/1991
	Tripartite Consultation (International Labour Standards Convention) 1976, (No.144)	16/05/1978	06/06/2011
	Occupational Safety and Health Convention, 1981, (No. 155)	11/08/1983	28/01/1991
	Workers with Family Responsibilities Convention, 1981 (No. 156)	11/08/1983	28/01/1991
	Termination of Employment Convention, 1982 (No. 158)	23/11/1985	28/01/1991

3.5. Project Financing Requirements

The project has considered good international industry practice (GIIP) as summarised by the standards and guidelines below.

3.5.1. Equator Principles

The Equator Principles were developed in June 2003, by a group of leading private banks and the International Finance Corporation (IFC). Over 118 financial institutions have adopted the Equator Principles covering the majority of international project finance debt in developed and emerging markets (http://www.equator-principles.com/).

The current set of principles (2020) are regarded as the financial industry's benchmark for determining, assessing, and managing social and environmental risk in project financing. The principles require that projects such as theTula Kapi Gold Project (Category A project) are subject to a social and environmental impact assessment and observe the relevant IFC Performance Standards (January 2012) and IFC Environmental Health and Safety (EHS) Guidelines (April 2007).

3.5.2. IFC Performance Standards

The IFC is a member of the World Bank Group and the IFC's Performance Standards on Social and Environmental Sustainability, which were updated in January 2012, are recognised as being the one of the most comprehensive standards available to international finance institutions working with the private sector. All eight IFC Performance Standards are relevant to the project. The standards cover the following subjects:

- **PS 1 Assessment and Management of Environmental and Social Risks and Impacts** – provides guidance on the environmental and social management system process, including impact assessment, community engagement, management planning and monitoring.
- **PS 2 Labour and Working Conditions** – particular emphasis is placed on fair treatment, health, and safety of workers.

- **PS 3 Resource Efficiency and Pollution Prevention**– provides guidance on preventing or minimising pollution risks.
- **PS 4 Community Health, Safety and Security**– covers project-related activities such as infrastructure and equipment safety, environmental and natural resource issues and emergency preparedness and response in case of the broader community.
- **PS 5 Land Acquisition and Involuntary Resettlement**– covers compensation and benefits for displaced persons, community consultation, grievance mechanism, resettlement planning and implementation to ensure appropriate displacement of people where required in collaboration with governments.
- **PS 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources**– provides guidance on the avoidance of adverse impacts on biodiversity and ecosystem services. Any conversion or degradation should be mitigated with the aim of managing renewable natural resources in a sustainable manner.
- **PS 7 Indigenous Peoples**– provides guidance on the avoidance of adverse impacts on indigenous communities and promotes effective communication.
- **PS 8 Cultural Heritage**– protect cultural heritage and support its preservation.

The IFC Performance Standards are matched with corresponding Guidance Notes that provide guidance on the requirements contained in the Performance Standards and on good sustainability practices to help clients improve project performance. These Guidance Notes are updated on a regular basis.

3.5.3. National and International Environmental Standards

During the ESIA process, specialist studies are undertaken, and impacts are assessed. These assessments are determined based on various relevant national and international environmental standards and regulations.

Table 3-5 below outlines the Ethiopian and international laws, regulations and guidelines that govern the framework for the specialists' studies undertaken for the TKGP. Where Ethiopian laws, regulations and guidelines were insufficient or not in place international guidelines and best practices were adopted.

Table 3-5: Applicable environmental standards during specialists' studies

Specialist study	Environmental standards
Air Quality	The air quality impact assessment ("AQIA") was conducted in terms of both the World Health Organisation ("WHO") guidelines and IFC ambient air quality standards for open pit mining. The IFC and WHO do not provide standards or guidelines for total suspended particulate ("TSP") or fallout dust therefore the South African draft regulations, derived from and aligned with international best practice guidelines (ASTM D1739), were used to form a base for comparison.
Climate change and greenhouse gas ("GHG") emissions	Ethiopia has no specific standards or guidelines for climate change and/or GHG emissions assessments. This assessment was conducted in terms of the Greenhouse Gas Protocol, IFC's Environmental and Social Performance Standards (2012), and the Equator Principles (2020).
Cultural heritage	The FDRE Cultural Policy proclamations No.229/66, 36/89, and 209/2000. Proclamations 299/2002 regulate cultural-environmental interactions, and international guidelines established by the World Bank, IFC and UNESCO World Heritage Convention (to which Ethiopia is a party) were also included.
Effluent standards	Ethiopia has no national standards governing effluent discharges from industries. However, since 2003 Ethiopia has had draft regulations governing the quality of the effluent discharged from facilities to public sewers and surface water systems (EPA, 2003). These draft guidelines were considered in the studies.

Hydrology	Wastewater Effluent and Storm water; and Water Supply and Resources (IFC, 2007) were applied in the hydrology study. The IFC Mining Guidelines (Industry specific) were applicable for water quality standards.
Noise	Ethiopia has no national legislation for noise, but World Bank guidelines have been adopted by MEFCC and are used for benchmarking purposes along with the draft National Noise Standards that are being prepared.

4. APPROACH AND METHODOLOGY

This section of the ESIA details the approach and methodology used to identify and assess potential project impacts and impact receptors and recommend appropriate mitigation measures. It outlines the following aspects of the EIA:

- Objectives of the EIA process.
- Approach adopted in the development of the EIA.
- Impact assessment methodology used in this EIS report.
- Stakeholder engagement activities undertaken throughout the EIA process.

The assumptions and limitations associated with the process, approach and methodology are also provided in this section.

4.1. EIA Objectives

EIA Proclamation No. 299/2002 requires EIA licenses be obtained for projects with potential to have significant impacts. The EIA process aims to inform decision-making and condition-setting by Ethiopian authorities in accordance with the country's laws. As far as possible, the process has been aligned with GIIP.

TKGM was granted a large-scale mining licence (i.e. MOM\LSML\81\2015) to exploit a gold deposit in western Ethiopia in 2015. An Environmental and Social Impact Assessment (ESIA) for the project was initially approved in 2015 by the Ministry of Mines and Petroleum with condition. Several review and update work done since 2015 to address the conditions stipulated by MoM, as well as updates to baseline data and infrastructure changes which occurred since the submission of the ESIA report. In accordance with Ethiopian legislation, TKGM followed the ESIA process comprises the elements summarised in table 4-1, table 4.2.

Table 4-1: Outline of the ESIA process Phases

Year	EIA Phases	Main purpose of each step
2010	Scoping	• Produce a draft plan/ Terms of Reference ("ToR") for the EIA that is acceptable to stakeholders covering concerns, identifies the issues/ impacts for the EIA, and research and assessment methods. • Stakeholders, including government officials and local communities, are identified and consulted to help identify key issues/ impacts and input to the ToR.
2011, 2014, and 2018	Baseline studies	• Undertake baseline specialist studies to provide a reference point of the state of the environment (bio-physical and social) for future monitoring and evaluation of performance.
2015, 2018, 2020 and 2023	Impact assessment and management planning	• Define/quantify impacts and determine the significance of each impact and evaluate acceptability of the Project and individual impacts. • Prepare the baseline/ impact assessment component of the EIS. • Prepare an environmental and social management plan ("ESMP") to eliminate or reduce negative impacts and enhance positive impacts. • Link the ESMP to the environmental and social management system ("ESMS") and define the monitoring requirements in the ESMP.
2015, 2020 and 2023	EIS and ESMP reporting, review, and decision making	• Undertake feedback stakeholder engagement to explain how stakeholders' concerns raised during scoping consultations have been addressed in the ESIA report • Submit the ESIA report to the authorities for decision-making.

4.2. Study Area

The study area for the project includes the project footprint (the physical area taken up by the development with its associated infrastructure) combined with the area of influence, which comprises areas potentially affected by the project. The study area for each baseline study differs based on the environmental or socio-economic component under consideration. For several baseline studies the study area was divided into two spheres as follows:

- A **primary sphere**, which comprised the areas in the immediate vicinity of the proposed project activities. For example:

- **Socio-economics**: the surrounding communities (kebeles), specifically Tulu Kapi Guracho kebele, Gudeya Guji kebele, and Bikilitu Ankuri kebele.
- **Surface water**: the catchments within which the direct footprint of project infrastructure is located.
- **Biodiversity and natural resource use**: habitats within approximately 3 km of project infrastructure.

- A **secondary sphere**, which encompassed a wider area surrounding the primary sphere. For example:
  - **Socio-economics**: the genji woreda, west Wellega zone, Oromia Regional State and Ethiopia generally.
  - **Surface water**: the downstream catchments that form part of the wider Biribir and Baro Akobo basins.
  - **Biodiversity and natural resource use**: the wider eco-region within which the project infrastructure is located (i.e., the East eco-region).

Within the primary sphere, primary and secondary data was collected and analysed to characterise the area, while within the secondary sphere the studies relied on secondary data sources.

4.3. EIA Approach

4.3.1. Scoping and Compilation of the ToR for the EIA

The activities undertaken during the scoping phase of the EIA process included:

- Desktop review and an environmental and social scan - the scan was undertaken in January 2015, to understand the bio-physical and social setting of the wider project area (mine-related infrastructure and power line corridor). The EIA team also met with key government stakeholders (including the Ministry of Mining and Petroleum, Ministry of Water, Irrigation and Energy, Ministry of Environment and Forestry, and Ministry of Cultural Heritage) to discuss the initial project concept, along with EIA-related procedural and substantive matters.
- Review of Ethiopian legislative and international guideline requirements.
- Identification and review of key stakeholder groups and representatives, and preparation of a draft EIA stakeholder engagement plan (ESIA-SEP).
- Stakeholder engagement with interested and affected parties (further detail is provided in Section 4.4).
- Interaction with the client and the engineering team regarding potential environmental/ social opportunities and risks to inform consideration of project alternatives.

4.3.2. Specialist Studies

Specialist studies were performed to provide information on the environmental and social setting of the project, characterize the pre-disturbance environment and provide a baseline against which impacts can be assessed and monitored. The following studies were undertaken as part of this ESIA process:

- Climate
- Hydrology and hydrogeology
- Water quality
- Soils and land capability
- Geochemistry
- Biodiversity
- Natural resource use
- Socio-economics
- Archaeology and cultural heritage
- Ecosystem services
- Noise
- Air quality
- Traffic

Further detail on the methodology and results of these studies is given in Chapters 5

4.3.3. Development of ESMP

The management measures in the project description and any additional management measures identified during the impact assessment are captured in the ESMP, which is presented in Chapter 0 of this EIS. This includes measures to prevent, eliminate or minimise negative impacts and enhance positive impacts. This represents TKGM's commitment to manage the impacts identified by the impact assessment process. The ESMP is a dynamic document, which will be revised and updated during the life of the project.

4.3.4. EIS and ESMP Report Review and Decision Making

The EIS will be submitted to the relevant regulatory authorities for review and consideration. The review will inform the government's decision and any conditions of approval.

4.3.5. Impact Assessment Methodology

Impact assessment is a continuous process starting with issue and impact identification during the scoping phase (Section 4.3.1). As the EIA progresses, the emphasis shifts to impact definition and evaluation, which consists of the systematic evaluation of each of the identified impacts using criteria enabling the significance of the impacts to be determined and the impacts to be ranked accordingly. As part of this process, management measures are identified that might reduce the significance of negative impacts or enhance positive ones. After consideration of the management measures, the significance of the resulting (residual/optimised) impacts is re-evaluated using the same criteria. The impact assessment findings are contained in this Chapter 7 of the ESIA report, and the identified management measures form the basis for subsequent development of the Project's ESMP contained in Chapter 8.

The definition of impacts is ongoing through the ESIA process and generally entails developing a description of the aspect, pathway and receptor that comprise the impact, as outlined below:

- Aspect: the mechanism by which project activities may cause impacts (such as gaseous emissions to the atmosphere or effluent discharges to a water body).
- Receptor: person, natural ecosystem, structure, or social system that experiences the impact.
- Pathway: mechanism by which the aspect affects the receptor (such as inhalation of air or drinking of water).
- Impacts: a plausible pathway between the project aspects and receptors. The aspects, pathways and receptors are identified based on experience of the EIA team, supported by the following:
  - Baseline information: consideration of relevant environmental/ social primary and secondary baseline information.
  - Project description: review of the evolving project description to identify aspects.
  - Area of influence: consideration of the area of influence to determine pathways and receptors (Study Area as defined in Section 4.2).
  - Stakeholder issues: consideration of issues raised by stakeholders (see Section 4.4).

Impact evaluation is not a purely objective and quantitative exercise. It has a subjective element that is often based on qualitative judgement and values, as well as scientific criteria. Consequently, the impact section in this report puts emphasis on describing how impacts have been interpreted so others can understand the rationale of the assessment. Key terminology used in describing impacts is given below.

Table 4-2: Characteristics Used to Describe an Impact

Characteristics	Sub-components	Terms used to describe the impact
Type		• positive (a benefit), negative (a detriment) or neutral
Nature of Impact		• bio-physical, social, cultural, health or economic • direct, indirect, or cumulative
Phase of Project		• construction, operation, decommissioning, or post closure
Intensity	Sensitivity of receptor	• high, medium, or low capacity to accommodate change • high, medium, or low conservation importance • vulnerable or threatened • rare, common, unique, endemic

Characteristics	Sub-components	Terms used to describe the impact
	Importance or value of receptor	• high, medium, or low concern to some or all stakeholders • high, medium, or low value to some or all stakeholders (for example, for cultural beliefs) • locally, nationally, or internationally important • protected by legislation or policy
	Severity or degree of change to the receptor	• gravity or seriousness of the change to the environment • intensity, influence, power, or strength of the change • never, occasionally, or always exceeds relevant thresholds
Extent	Area affected by impact - boundaries at local and regional extents will be different for bio-physical and social impacts	• area or volume covered • distribution • local, regional, trans boundary, or global
Duration	Length of time over which an environmental impact occurs or frequency of impact when intermittent	• short term or long term • intermittent (what frequency) or continuous • temporary or permanent • immediate effect (impact experienced immediately after causative project aspect) or delayed effect (effect of the impact is delayed for a period following the causative project aspect)
Probability - likelihood or chance an impact will occur		• definite (impact will occur with high likelihood of probability) • possible (impact may occur but could be influenced by either natural or project related factors) • unlikely (impact unlikely unless specific natural or project related circumstances occur)
Reversibility/Sustainability		• potential for recovery of the endpoint from a negative impact • reversible or irreversible • sustainability for positive impacts
Confidence in impact evaluation (degree of certainty in the significance ascribed to the impact)		• scientific uncertainty – limited understanding of ecosystem (or community) and processes governing change • data uncertainty – restrictions introduced by incomplete or incomparable information, or by insufficient measurement techniques • policy uncertainty – unclear or disputed objectives, standards, or guidelines

The impact significance rating process serves two purposes: firstly, it helps to highlight the critical impacts requiring consideration in decision making processes (such as engineering planning decisions, government approval of the project, the feasibility decision and project finance approvals); secondly, it serves to show the primary impact characteristics, as defined above, used to evaluate impact significance.

The impact rating methodology involves three parts as outlined below.

- **Part A: Impact consequence definition:** Defining of impact consequence as per Part A, Table 4-3 using the three primary impact characteristics of magnitude, spatial scale, and duration. The justification for the assessment should be clearly explained in the impact discussion. In the case of negative impacts, the most conservative definition should generally be used – in other words, if any of the definitions fall under the major category then the overall magnitude is major (precautionary principal). For positive impacts, a balance should be sought with the rating reflecting the most likely definition that applies.
- **Part B: Impact consequence rating:** Determination of the rating for impact consequence using the matrix based on the definitions identified in Part B, Table 4-3.
- **Part C: Impact significance rating:** Determination of the impact significance rating using the matrix, which is a function of the impact consequence rating (from Part B) and the probability of occurrence Part C, Table 4-3. The probability relates to the likelihood of the impact occurring, not the probability the Project activity that is the source of the impact occurs. For example, a continuous Project activity may have an unlikely probability of impact, if there are no receptors within the area influenced by that activity.

Table 4-3: Method for Rating the Significance of Impacts

Part A: Defining Consequence in Terms of Intensity, Duration and Extent Use these definitions to define the consequence in Part B			
Impact characteristics	Definition	Criteria	
Intensity	Major	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded	
	Moderate	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded	
	Minor	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded	
	Minor+	Minor improvement; change not measurable; or threshold never exceeded	
	Moderate+	Moderate improvement; within or better than the threshold; or no observed reaction	
	Major+	Substantial improvement; within or better than the threshold; or favourable publicity	
Duration/ frequency		Continuous aspects	Intermittent aspects
	Short term/ low frequency	Less than 2 years	Occurs less than once a year
	Medium term/ frequency	More than 2 years up to end of life of mine (approximately 14 years total)	Occurs less than 10 times a year but more than once a year
	Long term/ high frequency	Beyond the life of the mine (greater than 14 years)	Occurs more than 10 times a year
Extent		Environmental	Social
	Small	Within 1,000m of project footprint area	Within the local communities in which the activity occurs
	Intermediate	Within 5,000m of project footprint area	Within the Woreda in which the activity occurs
	Extensive	Further than 5,000m of project footprint area	Beyond the Woreda in which the activity occurs
Part B: Determining Consequence Rating Rate consequence based on definition of magnitude, spatial extent and duration			

Magnitude	Timeframe	Spatial scale		
		Small	Inter-mediate	Extensive
Minor	Short term / low frequency	Low	Low	Medium
	Medium term / frequency	Low	Medium	Medium
	Long term / high frequency	Low	Medium	Medium
Moderate	Short term / low frequency	Low	Medium	Medium
	Medium term / frequency	Medium	Medium	High
	Long term / high frequency	Medium	High	High
Major	Short term / low frequency	Medium	Medium	High
	Medium term / frequency	Medium	Medium	High
	Long term / high frequency	High	High	High
Part C: Determining Significance Rating Rate significance based on consequence and probability				
		Consequence		
		Low	Medium	High
Probability (of exposure to impacts	Definite	Low	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

+ denotes a positive impact.

The overall significance rating reflects a combination of the impact consequence, timeframe, and probability of occurrence. The outcome of this rating system is given in a rating table for each of the identified impacts in Chapter 7. The initial impact rating considers the applicable management measures inherent in the project design as described in the project description.

To further reduce the significance of negative impacts or enhance positive ones, additional management measures are then defined and documented in the impact rating table after which the residual/optimised rating is given (in some cases this may not differ from the initial impact rating). The strategy for selecting additional practical management measures is as follows:

- **Enhance the benefits:** Where positive impacts are anticipated, measures to further enhance these are included (where possible).
- **Avoid the impact**: It is always preferred to remove the cause(s) of impacts.
- **Reduce the impact**: Where impacts cannot be avoided, it is preferred to limit the cause(s) as far as possible.
- **Ameliorate the impact**: Only where the causes of the impact cannot be reduced, it is aimed to protect the receptor from the cause(s) of the impact.
- **Provide measures to offset the impact**: Only when none of the above approaches are possible, measures are implemented to offset the impacts.

Table 4-4: Definition of residual impact ratings

Significance	Definition of residual significance ratings
Low	Indicates minor improvement (positive impacts) or deterioration (negative impacts) to receptors or the receiving environment that can be easily managed and therefore should have little influence on decisions on the project.
Medium	Indicates moderate improvement (positive impacts) or deterioration (negative impacts) to receptors or the receiving environment that require careful monitoring to confirm the effectiveness of the management measures.
High	Indicates substantial improvement (positive impacts) or deterioration (negative impacts) to receptors or the receiving environment. These are the main impacts that may influence decisions on the project, noting the need to consider these on balance (i.e., positive impacts can only arise in association with negative impacts).

A statement is provided in the impact rating table regarding the **confidence of the assessment**, which gives the reader an indication of the **assurance level** placed on the rating process and addresses the concept of **uncertainty**. A statement is also given on whether the impact is **reversible** or **sustainable**.

Cumulative impacts consider other proposed or anticipated future activities in the vicinity of the project. Cumulative issues are considered in Section 9.

4.4. Stakeholder Engagement

This section of the report provides an overview of the stakeholder engagement process for the project, as shown schematically in Figure 4-1. The term 'stakeholders' used in this ESIA refers to individuals, groups, institutions and organisations who may be interested in or affected by the project, or who may have an ability to influence decisions concerning the project.

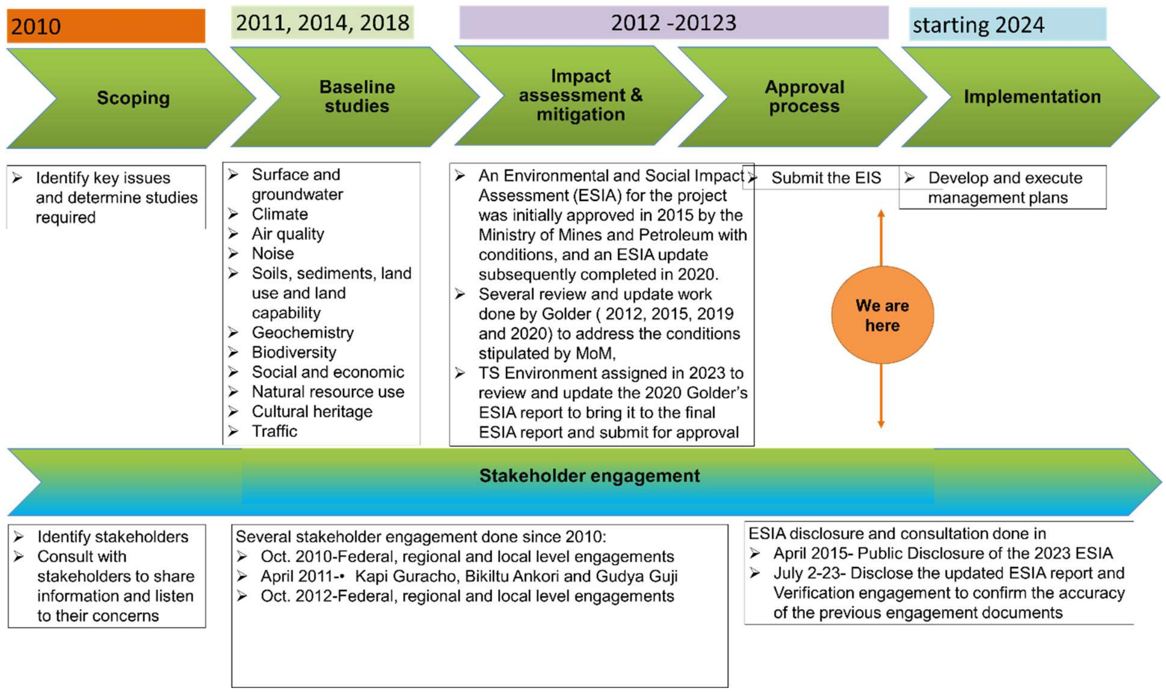


Figure 4-1: Summary of the EIA and Stakeholder Engagement Process

Initial stakeholder consultation during proposal screening made it obvious that the communities in the project region placed a high priority on respecting the existing traditional and governmental authorities as well as community organizational systems. In order to consult stakeholders, TKGM has used a top-down strategy, starting with getting in touch with the relevant governing and regulating agencies at the federal, regional, zone, Woreda, and individual Kebele (community) levels. The goal of engagement at the highest levels of government was to get pertinent policy directives and guidelines on the ESIA as well as to win official backing for the Project. These gatherings served as one instrument in the search for more IAPs.

The purpose of the meetings at the Woreda and community levels was to gather suggestions for addressing perceived negative effects and maximizing the project's advantages. Discussions on potential negative and positive effects of the Project to the community were part of the meeting agenda. One of numerous approaches utilized to identify vulnerable groups that might be affected was high level stakeholder dialogue. Women's groups and youth groups are examples of vulnerable communities that have been designated for consultation at the local level. The specific project impacts on women, children, and men were determined, and these stakeholder groups were consulted. This was done to ensure that marginalized stakeholder viewpoints were taken into account while planning the impact mitigation measures.

Women's participation in mixed-gender community consultation meetings was found to be rather low during the first round of consultations. In the presence of their male counterparts, women in the Project area community often hold back from publicly expressing their opinions and needs. As an illustration, only five of the 139 people who attended the community consultation meeting for Kapi Guracho on April 4, 2011, were women. Household leaders were identified as these five women. In order to address this social dynamic, a separate meeting for women's consultation was convened to ascertain the local women's unique concerns and give proper regard to the issues brought up by female IAPs.

In order to replace the previous Community Liaison Officers ("CLOs"), who had been serving the community since 2008, TKGM selected three new CLOs in 2011. The CLOs are kept on staff to help TKGM, the kebele administration, and community members communicate information. In order to improve the capacity for stakeholder consultation and communication, two new CLOs were hired in 2012. The CLOs are the main channel for effectively and easily reaching out to community stakeholders about the Project. The five CLOs who are now working in the Project area are seasoned Ethiopian citizens with graduate degrees in social science, development management, and rural economics. They are also fluent in the Afan Oromo dialect of the region as well as Amharic, English, and English. Prior to any announcement or public consultation, CLOs get in touch with the kebele administration. From there, the administration uses conventional word-of-mouth networks to reach out to each individual family in the kebele. Prior to the appointment of the CLOs, the kebele and woreda levels employed the same word-of-mouth method to identify the stakeholders and IAPs indicated below.

A list of the stakeholders is shown in Table 4-5. According to TKGM (undated), these individuals or organizations may be directly or indirectly impacted by the project, or they may have an interest in or power to influence it.

Table 4-5: Key identified stakeholders (TKGM, undated)

Stakeholder group	Stakeholders
Project affected communities	• **Directly:** Individuals, households, extended family groups, and community groups that will be displaced by the TKGP. The TKGP will directly impact these people, and most will need to be resettled or relocated, while these and others will need alternative access to farmland or livelihoods. This includes all landholders and their family members in the Project area • **Indirectly:** Communities living around the Project area who will observe changes in their local surroundings because of the TKGP and will interact with the Project in different ways **Vulnerable groups:** • Landless farmers and sharecroppers are a primary special interest group in the Project area • Elderly persons in the Project area • Disabled, handicapped or chronically ill persons in the Project area **Youth groups or 'Qeerro'**
Government authorities	**Federal Democratic Republic of Ethiopia (FDRE):** • Office of the Prime Minister • Ministry of Mines & Petroleum and Natural Gas ("MoMPNG") • MoFEC • Environmental Protection Authority ("EPA") • National Bank of Ethiopia • Ethiopian Roads Authority ("ERA") • EEPCo **Oromia Regional State:** • President's Office • Vice President's Office • Minerals Development Office • Rural Land Administration • Development Induced Displaced Communities' Affairs Agency • Roads Office • Environmental Protection Office **West Wollega Zone:** • Administration Office • Minerals Development Office • Rural Land Administration • Construction Office **Genji Woreda:** • Administration Office • Rural Land Administration • Labour & Employment Office • Environmental Protection Office • Construction Office • Women's Affairs Office • Cooperative & Promotion Office • Education Office

	• Health Office • Agriculture Office • Environmental Protection Office **West Wollega Zone:** • Administration Office • Minerals Development Office • Rural Land Administration • Construction Office **Genji Woreda:** • Administration Office • Rural Land Administration • Labor & Employment Office • Environmental Protection Office • Construction Office • Women's Affairs Office • Cooperative & Promotion Office • Education Office • Health Office • Agriculture Office **Neighbouring Woredas:** • Guliso Woreda • Lalo Asabi Woreda **Kebeles:** • Bilkitu Ankori • Kapi Guracho • Gudeya Guji

Cultural or traditional authorities	**#Religious leaders of the local church denominations in the Project area**:
	• Muluwengel
	• Mekaneyesu
	• Adventist (Afura)
	• 7th Day Adventist
	• Ethiopian Orthodox
	• **Gada System:** The 'Gada' System is the traditional governing organization of the Oromo people
	• **'Gare' leaders:** The "Gare" system is the most localized formal governing structure in the Oromia Region of Ethiopia. The Gare leader is responsible for liaising between the households which he represents and the relevant kebele administration and committee
	• '**Qeerro' and 'Qeerra':**
	  ○ The 'Qeerro' is a term used loosely in Ethiopia today to refer to young and empowered men who are use political organization in different forms to pursue improved rights of the Oromo people
	  ○ "Qeerra" is the female version of the Qeerro, however in practice the Qeerra is not as politically active or organised as their male counterparts, and there are no female representatives in the government structures

Inte rested parties	• TKGM and KEFI shareholders and the investment community • People or groups who have knowledge about the project and its operations • Partners or contractors working with TKGM • Part of the broader regional community, civil society groups, political organizations, NGOs, industry interest groups etc. • Ethiopian media and the public • Potential suppliers and other business communities • International organisations or non-governmental organisations interested in mining projects in developing countries

4.4.1. Stakeholder Consultation Programme

To adapt to new facts, evolving circumstances, or changes in public opinion, consultation is methodical and adaptable. The consultation procedure is fully documented, and as described in APPENDIX D, APPENDIX E, and APPENDIX F, impacted communities and other interested parties get feedback. Official consultation with federal, regional, and Zone officials was carried out in October 2012 (facilitated by unaffiliated consulting firms). In October 2010, April 2011, October 2012, and April 2015, community consultations were held at the woreda and kebele levels and included people from disadvantaged communities. Appendices E and F include the records of these public consultations. During consultation, it was recorded the community's knowledge, views of the positive and negative project consequences, and proposed mitigation solutions. Women and young people were among the vulnerable stakeholder groups that were identified and consulted with particular project impacts, ensuring the inclusion of marginalized stakeholder perspectives in the planning for impact mitigation.

ESIA disclosure documents in Amharic are being publicly disseminated on an on-going basis as appropriate. Translation of these documents into the Afan Oromo, the local language in the Project area, is also being undertaken (APPENDIX F). These documents describe in plain language the project activities and potential impacts, as well as the role of IAPs. Women's and youth outreach and education programmes are on-going.

Table 4-6 below presents a summary of stakeholder consultations undertaken done to date as part of the ESIA process between 2010 and 2015, and comments recorded as stated without interpretation from specialists (for more details see APPENDIX E. and APPENDIX F).

Stakeholder engagement and consultation with local and regional key stakeholder done as part of this ESIA review and updates process by TS Environment (Table 4-6).

Table 4-6: Summary of stakeholder consultation programme

Year	Key Activities	Key Stakeholders Consulted	Key Findings
Oct. 2010	• Conveyed policy directives, guidelines, and other information relevant to conducting the ESIA to federal and regional organizations • Identified vulnerable groups and discussed the importance of stakeholder engagement to the success of the project • Identified anticipated positive and negative project impacts, and suggested negative impact mitigations • Secured commitment from representatives at federal, regional, Zone, Woreda and Kebele government levels to work with TKGM to mitigate negative impacts according to government policies and guidelines • Secured commitment from community members to communicate and collaborate closely with administrative officials and TKGM representatives	• Federal Ministry of Mining • Federal Environmental Protection Authority • Oromia Regional Land Use and Environmental Protection Authority • Western Wollega Zone Administration • Genji and Guliso Woreda • Administration • Genji Woreda Women's and Children's Affairs • Kapi Guracho Kebele	• Need to establish an on-going community awareness and consultation programme • Need to strengthen the network and communication between the company and the local governments • Need to ensure resettlement and other development programmes are gender sensitive and include socio-cultural concerns • Need to build the capacity of affected communities and need to ensure their active participation • Need to have in place an Environmental Protection Plan, • Environmental Management System, and regular monitoring • system to preserve the natural environment • Need to put in place HIV/AIDS and other emerging diseases prevention and control mechanisms and safety measures • Need to develop infrastructure and social services to • accommodate immigrants attracted by employment and other economic opportunities
Apr. 2011	• Obtain feedback on the first round of consultation, as well as additional information and areas of concern from directly and indirectly affected communities • Discussed anticipated impacts and suggested mitigation measures	• Kapi Guracho, Bikiltu Ankori and Gudya Guji Kebele Leaders	• Need for timely and appropriate compensation and resettlement mechanisms • Project activities may cause or aggravate impacts from • increased dust, erosion, landslides, and flooding • Local employment and educational opportunities are a concern • Potential disruption of traditional community values and structures • Need for improved community services (roads and water) • Need for clear lines of communication between community members, government administrators, and project proponents
Apr. 2011	• Obtain gender specific concerns from women's group • Discussed anticipated impacts and suggested mitigation measures	• Kapi Guracho Kebele Women's Association	• Need for clean, secure water supply • Roads should be upgraded to passable standards year-round • Women's employment opportunities in addition to • employment opportunities for their family members • Design and implementation of diversified economic activities appropriate to the local context

			• Well organized, equipped and staffed health care facilities • Establishment of a collective shop offering staples at reasonable prices • Electrical source for electric grinding mill and other economic activities

4.4.2. ESIA Disclosure engagement

TS Environment conducted an ESIA disclosure and verification engagement with the Local community representative and woreda administration
The following key personnel attended the workshop:

- Environmental

Table 4-7: Note from the ESIA disclosure and verification engagement (July 2023)

ID #	Checklist questioners	Stakeholder response
1	Knowledge and Information about	The participant discuss that TKGM has been busy in the project for more than 10 years and the local government and community have a clear knowledge about the project. The company also is working with the local government administration on several business and development issues. The word is eagerly waiting the starting of the mining operation.
2	TKGM's Stakeholder Engagement process	The participant confirmed that several stakeholder engagement have been underway at different times since 2010 and all member of the local community were briefed about the project
3	ESIA Consultation with relevant community members	The participant confirmed that several consultation with elders, religious leaders and youths at Gimbi town and near project site Starting from 2010.
4	Consultation with Project Affected Community	TKGM had several consultation with Project affected communities and all records are documented. However, recently consultation not possible due to the security situation at the project area
5	Socioeconomic baseline survey	A household survey was done by TKGM to document the socio economic condition of PAPs. The information include Demography, Economy, health, education and other.
6	Resettlement action Plan (RAP), Asset evaluation and compensation	The participant confirmed TLGM has developed RAP and the plan was designed with the consultation with PAP. According to proclamation number 455/2005 and regulation number 135/2007 asset evaluation and compensation determined The participant emphasis 1the compensation calculation shell be revised in accordance with 161/2019 proclamation .
7	Any other information	The participant emphasized that the high expectation to see TKGM starting the mining operation.

Further to this, TKGM (formerly KEFI)'s social team have undertaken numerous stakeholder consultations in 2014 and 2015 as part of the resettlement process. While these consultations do not form part of the ESIA process per se, they are important to note as they do demonstrate TKGM's commitment to active engagement and participation of all stakeholders involved in the resettlement process. Table 4-6 above presents a summary of stakeholder consultations (see APPENDIX G for more detail).

5. ENVIRONMENTAL BASELINE

5.1. Introduction

The 2020 ESIA report by Golder presents the baseline environmental conditions of the TKGM project site, and this 2023 ESIA review and update by TS Environment used the results of all specialist studies with little change to supplement the existing baseline information after a critical review of the analysis method employed and the conclusion made, as appropriate.

The environmental and social baseline of the TKGP covers analysis of the existing biophysical conditions as well as the socio-economic features prevailing in the Project area. Figure2-1 shows the boundary of the MLA and proposed location of the main infrastructure. Regional layouts were also provided in the introduction chapter. Baseline data has been compiled through a combination of desk top review and fieldwork. The majority of the fieldwork was undertaken from 2008 through to 2012, with additional fieldwork for selected specialist studies undertaken in 2015 and 2018.

The environmental baseline provides a database of physical, chemical, and biological parameters, which are used to predict and monitor the effects of the project on the environment.

The description of each environmental component includes a description of the methods used to collect primary data, a description of the regional setting based on available secondary information, leading to a site-specific description of the study area.

5.2. Climatic and Meteorological Overview

The TKGP is located within the temperate region of the Oromia highlands. It is understood that an automated weather station was installed at Project site in September 2010. However, due to insufficient data being available from the meteorological station, meteorological data from this station could not be utilized for this assessment.

TS Environment purchased a three years (2020, 2021 and 2022) MM5 meteorological data from Lakes Environmental Software. The data coverage was centred over the MLA (anemometer height of 14 m) with a grid cell dimension of 12 km x 12 km over a 50 km x 50 km domain. The 2020 ESIA were also presented result from MM5 for the period January 2017 to December 2019. However, it was not possible to use the data for analysis because the raw data was not accessible in the TKGM data system. However, this report's discussion of the 2020 ESIA report's average annual statistics is essential.

In the absence of a national or international certification framework, the South African National certification framework (SANAS, 2012) TR 07-03 criteria mandate that a dataset must have a minimum data recovery of 90% in order to be considered reflective of the circumstances for a certain reporting period. Since all recorded metrics had a 100% recovery rate, they are trusted to be used in this evaluation. Below is a discussion of the site's meteorological conditions using modelled MM5 data?

5.2.1. Temperature, Precipitation and Humidity

Temperature, precipitation, and humidity are key influencing factors in ambient air quality:

- Ambient air temperature affects both plume buoyancy and the development of mixing and inversion layers. Furthermore, the greater the difference in temperature between the plume and the ambient air,
- the higher the plume is able to rise
- Over the period January 2017 to December 2019, average temperatures ranged from approximately 20 to 23 °C. Minimum monthly average temperatures ranged from 12 to 18 °C, with maximum monthly
- average temperatures ranging from 26 to 30 °C (Table 5-1,table 5-2 and figure 5-1
- Rainfall is an effective removal mechanism of atmospheric pollutants as when it falls, it brings pollutants down with it. Rainfall further reduces the erosion potential by increasing the moisture content of erodible
- materials; and
- Most rainfall occurred during June to August, with the lowest rainfall levels during December to February (Table 5-3 , table 5-4 And figure 5-2Total rainfall received for 2017, 2018 and 2019 was approximately 2470 mm,
- 2570 mm, and 2188 mm, respectively. Relative humidity was generally moderate for 2017, 2018 and
- 2019 at 63%, 61% and 60%, respectively.

Table 5-1: Average temperatures (°C) for 2017 – 2019 (MM5 data)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	20	21	21	22	22	21	20	20	21	21	20	20
2018	20	21	22	21	22	21	20	20	21	21	21	20
2019	21	22	23	23	23	21	21	20	21	21	20	20

Table 5-2: Average temperatures (°C) for 2020 – 2022 (MM5 data)

Month	Temperature		
	2020	2021	2022
January	20.775	20.254	21.075
February	21.798	20.248	22.566
March	22.018	23.117	23.978
April	23.261	23.268	23.615
May	21.694	21.122	22.061
June	19.706	19.928	19.576
July	18.297	18.023	18.213
August	18.458	18.918	18.250
September	18.944	18.816	18.700
October	19.442	19.597	18.911
November	20.228	20.378	19.648
December	20.617	20.337	19.836

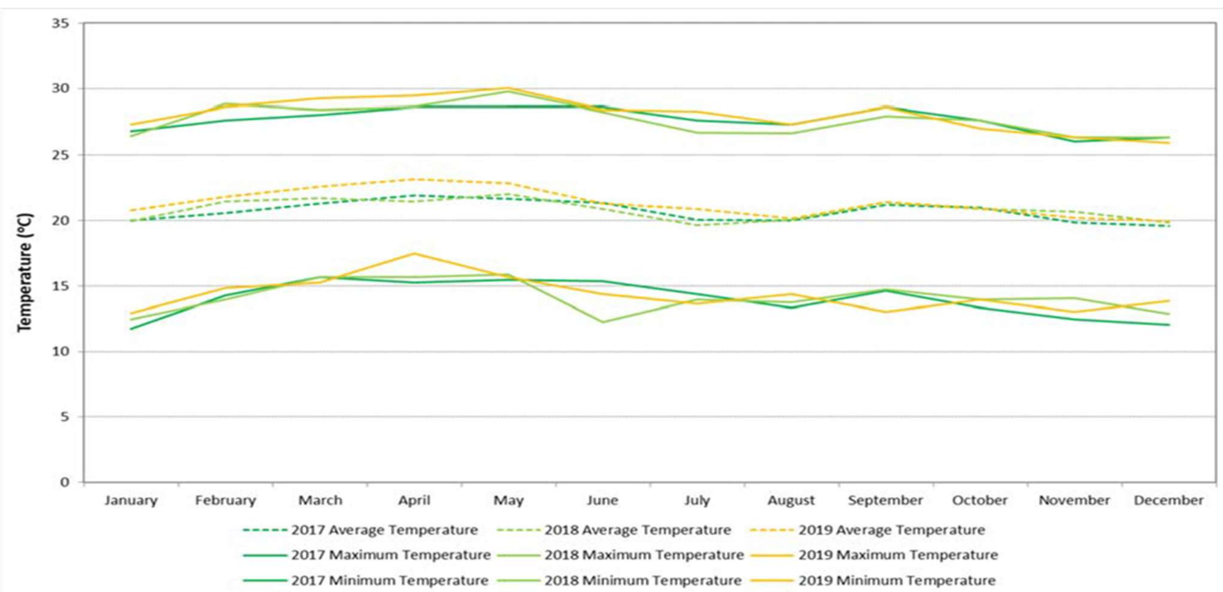


Figure 5-1: Average, maximum and minimum temperatures for 2017 to 2019 (MM5 data)

Table 5-3: Monthly rainfall (mm) for 2017 to 2019 (MM5 data)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	0	55	72	73	304	250	500	697	250	216	51	1
2018	10	22	44	136	233	502	828	536	142	101	15	1
2019	0	37	10	65	127	410	490	536	322	66	124	1

Table 5-4: Monthly rainfall (mm/hr.) for 2020 to 2022 (MM5 data)

Month	Rainfall		
	2020	2021	2022
January	0.011	0.007	0.007
February	0.017	0.014	0.007
March	0.010	0.073	0.032
April	0.098	0.124	0.199
May	0.512	0.343	0.325
June	1.025	0.802	1.049
July	0.645	0.494	0.546
August	0.616	0.676	0.689
September	0.562	0.564	0.840
October	0.251	0.366	0.427
November	0.018	0.053	0.047
December	0.010	0.055	0.016

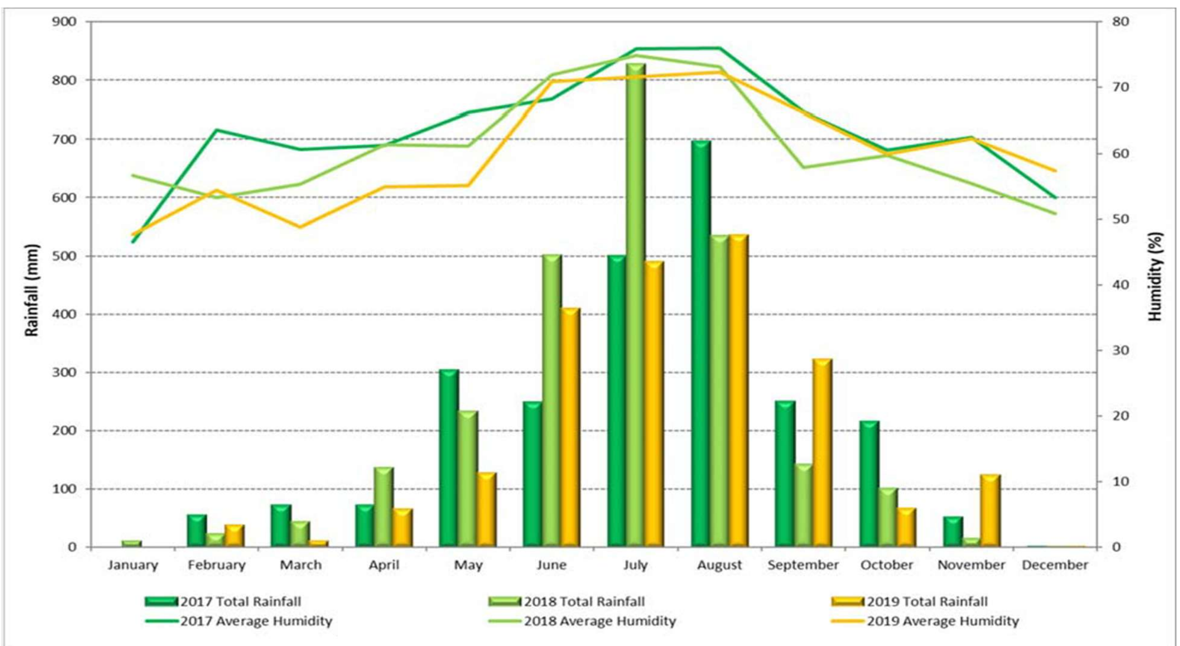


Figure 5-2: Monthly rainfall and average humidity 2017 to 2019 (MM5 data)

5.2.2. Wind Field

Wind roses summarise the occurrence of winds at a specified location by representing their strength, direction, and frequency. Each directional branch on a wind rose represents wind originating from that specific cardinal direction (16 cardinal directions). Each cardinal branch is divided into segments of different colours which represent different wind speed classes. The Lakes Environmental WRPLOT View v8.0.2 was used to create period, seasonal and diurnal wind roses for the MM5 data period 2017 to 2019 (Figure 5-3). The following can be observed from the wind roses:

- Winds during the period (2017 to 2019) originate predominantly from the east. Winds are light to moderate, with average wind speeds approximately 2.4 m/s and very few winds exceeding 8 m/s. Calm conditions (wind speeds < 1 m/s) are experienced 18.3% of the time

- Diurnal variations in winds indicate that winds originate predominantly from the east during the day (06:00 to 18:00), with a shift to dominant winds from the east-north-east experienced at night (18:00 to 06:00). Strongest wind speeds are experienced during the day, with a higher percentage of calms
- Seasonal variations show that winds originate predominantly from the east throughout the year, with the exception of June to August where dominant winds are from the south-south-west. Wind speeds are at their strongest from December to February with calm conditions experienced 10.8% of the time

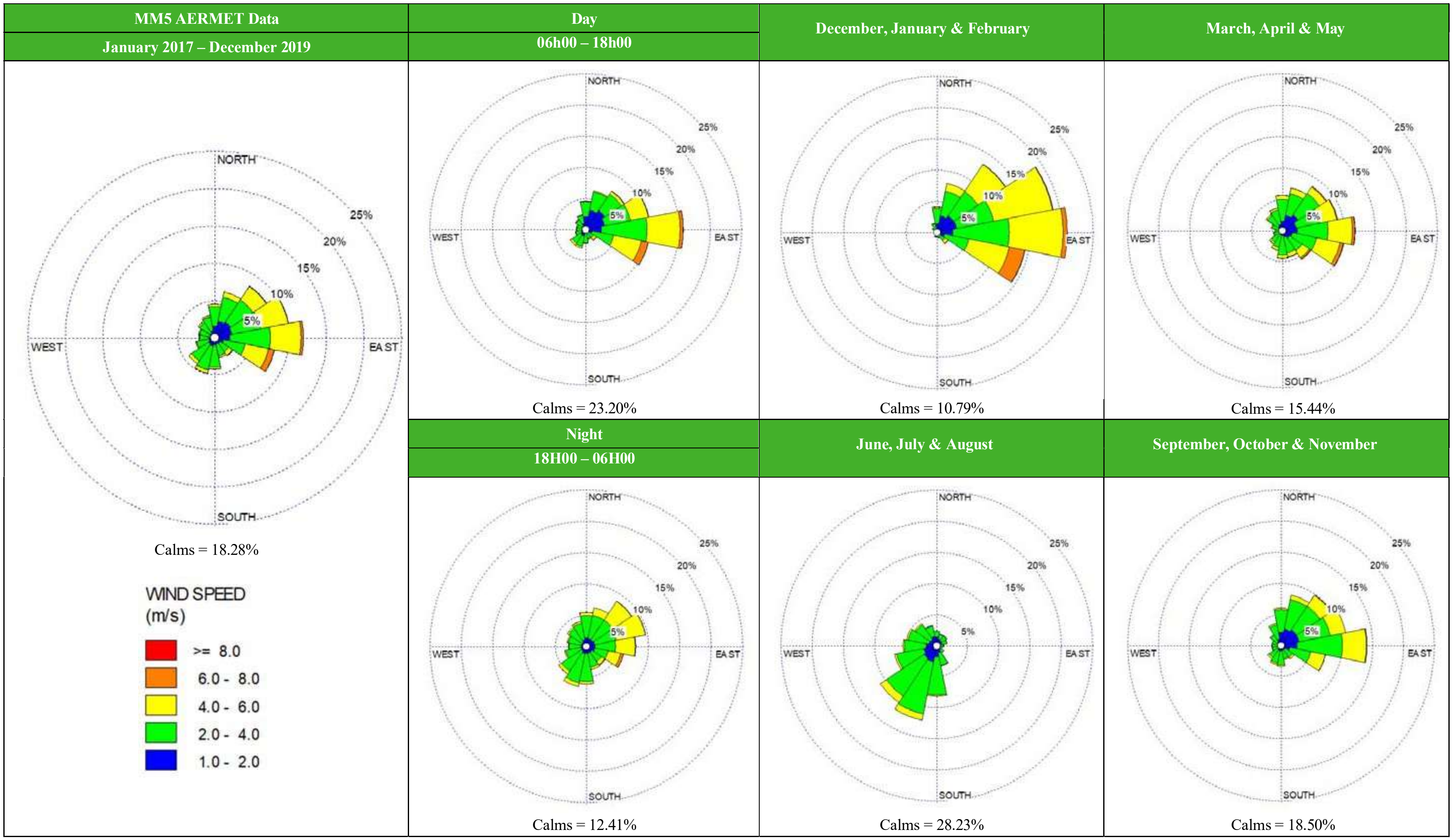


Figure 5-3: Wind conditions using MM5 data for the period 2017 to 2019

5.3. Ambient Air Quality Overview

5.3.1. Existing Sources

Existing sources of emissions to air within the area have been identified to include:

- Agricultural activities
- Biomass burning
- Domestic fuel burning

5.3.1.1. Agricultural Activities

Emissions from agricultural activities are difficult to control due to the seasonality of emissions and the large surface area producing emissions (USEPA, 1995).

Subsistence dry land agriculture is prominent in the Project area. Typical crops grown include maize, sorghum, groundnuts and sunflowers. Clearing of veld, ploughing and preparations of the fields for planting can generate dust fallout. Agricultural emissions, however, are not anticipated to significantly influence the air quality in the area although particulate emissions may increase during the dry season.

5.3.1.2. Biomass Burning

Biomass burning may be described as the incomplete combustion process of natural plant matter with carbon monoxide (CO), methane (CH4), nitrogen dioxide (NO2) and PM10 being emitted during the process. During the combustion process, approximately 40% of the nitrogen in biomass is emitted as nitrogen, 10% remains in the ashes and it is assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds. In comparison to the nitrogen emissions, only small amount of sulphur dioxide (SO2) and sulphate aerosols are emitted. With all biomass burning, visible smoke plumes are typically generated. These plumes are created by the aerosol content of the emissions and are often visible for many kilometres from the actual source of origin.

The extent of emissions liberated from biomass burning is controlled by several factors, including:

- The type of biomass material
- The quantity of material available for combustion
- The quality of the material available for combustion
- The fire temperature
- Rate of fire progression through the biomass body

Crop-residue burning and general wildfires represent significant sources of combustion-related emissions associated with agricultural areas.

5.3.1.3. Domestic Fuel Burning

Domestic fuel burning of coal emits a large amount of gaseous and particulate pollutants including SO2, heavy metals, total and respirable particulates, inorganic ash, CO, polycyclic aromatic hydrocarbons, and benzo(a) pyrene. Pollutants arising due to the combustion of wood include respirable particulates, NO2, CO, polycyclic aromatic hydrocarbons, particulate benzo(a) pyrene and formaldehyde.

The scattered rural households within the vicinity of TKGP rely on coal and wood burning for space heating and/or cooking purposes (SRK Consulting, 2011). Emissions from these households are therefore anticipated to impact the region, especially during the winter period due to the increased demand for space heating.

5.3.1.4. Ambient Air Quality Monitoring

It is understood that there is no recent (within the last five years) ambient air quality data available for the TKGP and such monitoring will only be undertaken later this year or next year in order to establish the baseline local air quality at the Project site.

Gaseous and PM10 monitors were however established on site in October 2010 and an air quality monitoring protocol was developed by SRK Consulting (SRK) in 2011. The 2020 ESIA update by Golder did analysis the monitoring records. Table 5-5 below presents the locations of the various monitoring locations as recommended by SRK for the TKGP, whilst Figure 5-4 illustrates the monitoring stations.

Table 5-5: Sampling locations for PM10 and gas monitoring at the Project site

Field ID	Sample	Co-ordinates (WGS) 84	Reason for Monitoring
DMNML01 (DM01)	PM10	09˚05’26.0’’ N 35˚34’37.2’’ E	Located to the north-east of the MLA.
DMNML02 (DM02)	PM10	09˚04’18.2’’ N 35˚34’18.6’’ E	Located to the south-east of the MLA.
DMNML03 (DM03)	PM10	09˚04’35.3’’ N 35˚33’24.3’’ E	Baseline monitoring of dust levels at the proposed main haul road.
DMNML04 (DM04)	PM10	09˚04’25.4’’ N 35˚33’10.4’’ E	Baseline monitoring of dust levels at the proposed location of the South WRD.
DMNML05 (DM05)	PM10	09˚05’17.7’’ N 35˚32’41.4’’ E	Baseline monitoring of dust levels at the school to the north-west of the MLA.
DMNML06 (DM06)	PM10	09˚04’55.8’’ N 35˚33’06.4’’ E	Baseline monitoring of dust levels within main pit.
DMNML07 (DM07)	PM10	09˚05’08.8’’ N 35˚33’47.1’’ E	Located to the west of the tailings storage facility to monitor baseline dust fallout in the immediate vicinity of the area.
GMNML02 (GM02)	SO2 and NO2	09˚04’18.2’’ N 35˚34’18.6’’ E	Located to the north-east of the MLA.
GMNML03 (GM03)	SO2 and NO2	09˚04’35.3’’ N 35˚33’24.3’’ E	Baseline monitoring of gas levels at the proposed location of the South WRD.
GMNML04 (GM04)	SO2 and NO2	09˚04’25.4’’ N 35˚33’10.4’’ E	Baseline monitoring of gas levels at the proposed location of the South WRD.
GMNML05 (GM05)	SO2 and NO2	09˚05’17.7’’ N 35˚32’41.4’’ E	Baseline monitoring of gas levels at the school to The north-west of the MLA.
GMNML06 (GM06)	SO2 and NO2	09˚04’55.8’’ N 35˚33’06.4’’ E	Baseline monitoring of gas levels within main pit.
GMNML07 (GM07)	SO2 and NO2	09˚05’08.8’’ N 35˚33’47.1’’ E	Located to the west of the tailings storage facility to Monitor baseline gas levels in the immediate vicinity of the area.

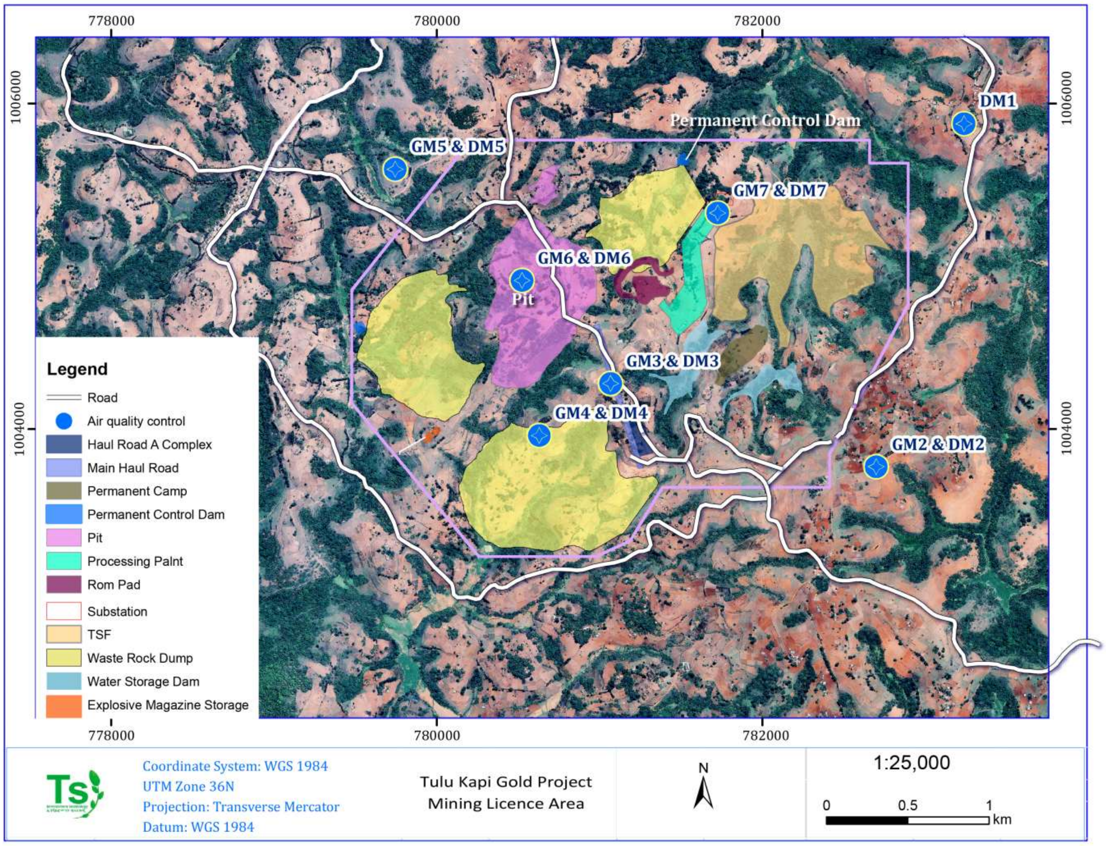


Figure 5-4: Location of the air quality monitoring stations at the Project site

Furthermore, PM10 concentration data from Station DM06 was received for the 6-month period from 28 November 2011 to 24 May 2012. This information is presented below, however should be viewed with caution given the time elapsed between the monitoring data and the project update. It is thus recommended that the baseline data be validation and updated once current monitoring data becomes available.

Data recovery for the PM10 monitoring at Station DM06 over the 6-month period (28 November 2011 to 24 May 2012), is given in Table 5-6. A minimum of 80 % data recovery is required to achieve minimum data quality assurance. As such, 3 months (November, December, and January) of data was excluded from the assessment. While the May data recovery did not reach the required minimum, it was however included in the assessment as it was only slightly below the minimum required.

Table 5-6: PM10 monitoring data recovery

Month	Data Recovery
November	12.9%
December	0%
January	12.9%
February	100%
March	100%
April	99.9%
May	75.8%

The 24-hour average PM10 concentrations recorded from 1 February 2012 to 24 May 2012, are illustrated in Figure 5-5 and benchmarked against the relevant international legislation. The results showed that the IFC ambient air quality guideline (50 µg/m^3) was exceeded 12 times (using a 100th percentile) over the entire monitoring period. It must be noted that due to the short monitoring period, the

TKGP's ambient air quality data could not be benchmarked against IFC annual arithmetic mean standards.

These exceedances were likely a result of the following:

- The data record largely fell during the dry, winter season which may have resulted in greater concentrations due to an increase in domestic fuel burning for heat, increase atmospheric stability, accompanied by temperature inversions, thereby trapping pollution. In addition, the lower rainfall received during this period would result in less dust suppression and therefore higher readings
- DM06 is located within the current exploration camp. Higher PM10 emissions are expected within the camp as a result of the concentration of dust producing mining activities in the area
- Drilling and earth moving activities were underway in the vicinity of the station at this time.

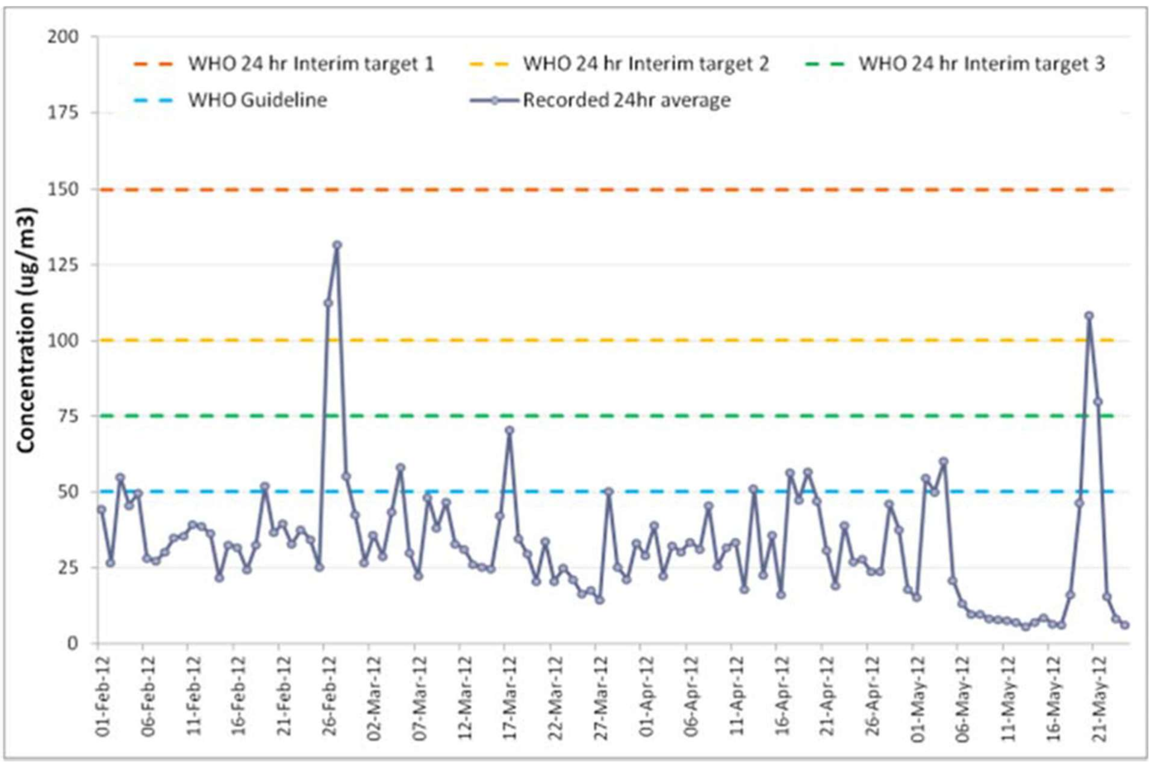


Figure 5-5: 24-hour average PM10 concentrations recorded at a TKGP monitoring station

5.4. Climate Change Projections

There is significant evidence to suggest that human influence on the global climate system is clear and that anthropocentric emissions of GHGs are the highest in history (IPCC, 2014).

Anthropogenic GHG emissions have increased since the pre-industrial era, driven largely by economic and population growth. This has resulted in global atmospheric concentrations of carbon dioxide (CO_2), methane, and nitrous oxide, that are unprecedented in at least the last 800 000 years. This increase in atmospheric concentrations of GHGs has been identified with a high level of confidence as the main cause of observed global warming since the mid-20th century.

Several climate models have been developed in recent years to simulate future climate change and the associated impacts. The predictions presented in this assessment are based on the 5th Phase of the Coupled Model Inter comparison Project ("CMIP5"), which comprises 35 global climate change models. CMIP5 is one of the most widely used models and is included in the Intergovernmental Panel on Climate Change ("IPPC")'s Fifth Assessment Report.

Anthropogenic GHG emissions are mainly driven by factors, such as population size, economic activity, land use patterns, and technology. Climate change models use different scenarios, referred to as representative concentration pathways ("RCPs"), for making predictions based on these factors. The following four RCPs are generally used:

- **RCP2.6:** Low emissions scenario, which aims to keep global warming below 2°C above pre-industrial temperatures
- **RCP4.5:** Low to medium emissions scenario
- **RCP6.0:** Medium to high emissions scenario
- **RCP8.5:** High emissions or business as usual scenario with no additional efforts to constrain emissions

Figure 5-6 (left) presents the trajectory of historical anthropogenic GHG emissions (shown as a black line) and the predicted emissions for each scenario or RCP. With RCP2.6, annual GHG emissions are predicted to be 0 giga tonnes carbon dioxide equivalent ("Gt CO_2e") by 2100, with Gt CO_2e concentration of 430 to 480 parts per million. At these concentrations, the temperature rise relative to pre-industrial levels is predicted to be 1.5°C to 2°C (Figure 38 -right). With RCP8.5, annual GHG emissions are predicted to be greater than 100 Gt CO_2e by 2100, with corresponding Gt CO_2e concentration greater than 1 000 parts per million. At these concentrations, the temperature rise relative to pre-industrial levels is predicted to be greater than 4°C.

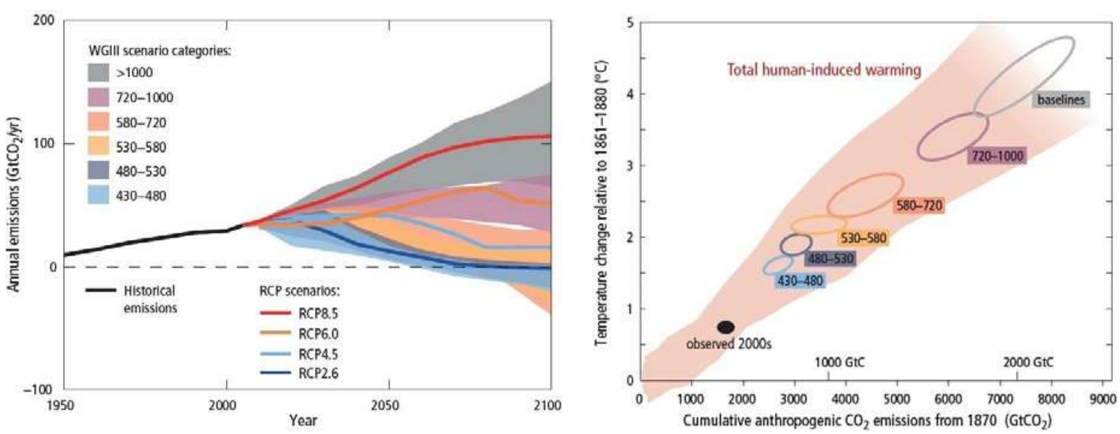


Figure 5-6: Annual anthropogenic GHG emissions (left) and warming versus cumulative anthropogenic GHG emissions (right) (IPCC, 2014)

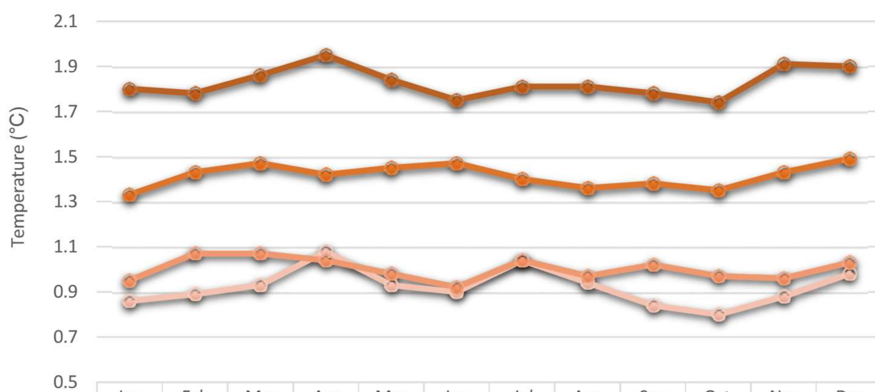
The following section presents an overview of climate change projections for the area in which the TKGP is located in the near (2020-2039) and distant future (2040-2059), under two GHG mitigation scenarios (RCP 4.5 low-medium emissions and RCP8.5 high emissions). This includes average monthly temperature, number of hot days (>35°C), average monthly precipitation, and precipitation from very wet days.

5.4.1. Temperature

5.4.1.1. Average Monthly Temperatures

Figure 5-7 presents the projected changes in average monthly temperatures at the TKGP in the near (2020- 2039) and distant future (2040-2059) under the low-medium (RCP4.5) and high (RCP8.5) GHG emissions scenarios.

In the near future, average monthly temperatures are projected to increase by 0.92°C (0.8°C to 1.08°C) in the low-medium emissions scenario and 1°C (0.98°C to 1.07°C) in the high emissions scenario. In the distant future, average monthly temperatures are projected to increase by 1.42°C (1.33°C to 1.49°C) in the low-medium emissions scenario and 1.83°C (1.74°C to 1.91°C) in the high emissions scenario.



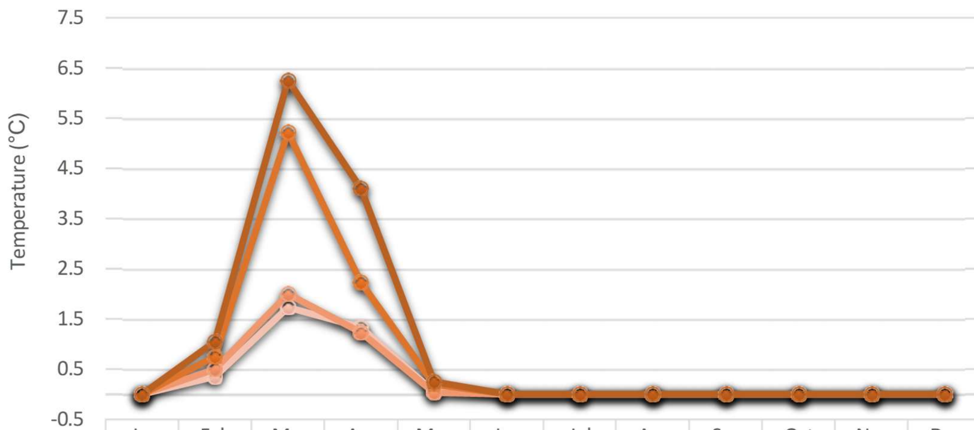
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RCP4.5 (2020-2039)	0.86	0.89	0.93	1.08	0.93	0.9	1.04	0.94	0.84	0.8	0.88	0.98
RCP8.5 (2020-2039)	0.95	1.07	1.07	1.04	0.98	0.92	1.04	0.97	1.02	0.97	0.96	1.03
RCP4.5 (2040-2059)	1.33	1.43	1.47	1.42	1.45	1.47	1.4	1.36	1.38	1.35	1.43	1.49
RCP8.5 (2040-2059)	1.8	1.78	1.86	1.95	1.84	1.75	1.81	1.81	1.78	1.74	1.91	1.9

Figure 5-7: Projected change in average monthly temperatures at the TKGP in the near and distant future (World Bank, 2020)

5.4.1.2. Hot Days (>35°C)

Figure 5-8 presents the projected changes in number of hot days at the TKGP in the near (2020-2039) and distant future (2040-2059) under the low-medium (RCP4.5) and high (RCP8.5) GHG emissions scenarios. Hot days are characterised as days where the temperature is equal to or greater than 35°C.

In the near future, the number of hot days is projected to increase by 3.5 days in the low-medium emissions scenario and 3.8 days in the high emissions scenario. In the distant future, the number of hot days is projected to increase by 8.4 days in the low-medium emissions scenario and 11.6 days in the high emissions scenario. In all scenarios, there will an increase in the number of hot days in February to May, with March experiencing the greatest increase in the number of hot days. There is no change in the number of hot days in the rest of the year.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RCP4.5 (2020-2039)	0	0.35	1.73	1.33	0.05	0	0	0	0	0	0	0
RCP8.5 (2020-2039)	0	0.5	2	1.23	0.03	0	0	0	0	0	0	0
RCP4.5 (2040-2059)	0	0.75	5.22	2.23	0.2	0	0	0	0	0	0	0
RCP8.5 (2040-2059)	0	1.05	6.25	4.1	0.25	0	0	0	0	0	0	0

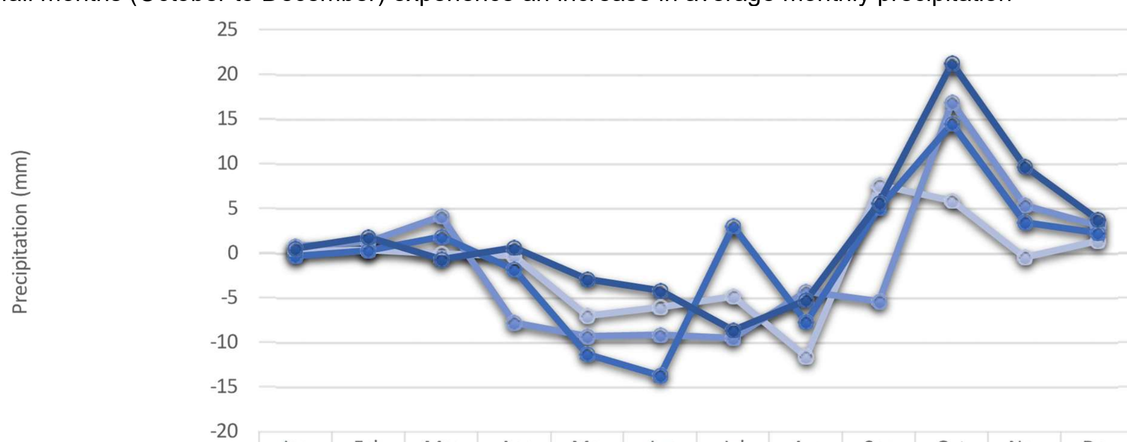
Table 5-8: Projected change in number of hot days at the TKGP in the near and distant future (World Bank, 2020)

5.5. Precipitation

5.5.1. Average Monthly Precipitation

Figure 5-9 presents the projected changes in average monthly precipitation at the TKGP in the near (2020-2039) and distant future (2040-2059) under the low-medium (RCP4.5) and high (RCP8.5) GHG emissions scenarios.

In the near future, average annual precipitation is projected to decrease by 15.5 mm in the low-medium emissions scenario and 14.7 mm in the high emissions scenario (World Bank, 2020). In the distant future, average annual precipitation is projected to decrease by 5 mm in the low-medium emissions scenario and to increase by 20.9 mm in the high emissions scenario. In all scenarios, the high rainfall months (June to September) experience the greatest decrease in average monthly precipitation, while the low rainfall months (October to December) experience an increase in average monthly precipitation



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RCP4.5 (2020-2039)	0.23	0.28	-0.12	-0.36	-7.07	-6.1	-4.89	-11.66	7.57	5.8	-0.5	1.31
RCP8.5 (2020-2039)	0.73	1.22	4.06	-7.85	-9.37	-9.22	-9.57	-4.36	-5.46	16.84	5.3	3.02
RCP4.5 (2040-2059)	-0.38	0.25	1.79	-1.87	-11.36	-13.75	2.97	-7.76	5.01	14.46	3.4	2.2
RCP8.5 (2040-2059)	0.47	1.73	-0.76	0.55	-2.98	-4.26	-8.7	-5.32	5.57	21.23	9.64	3.7

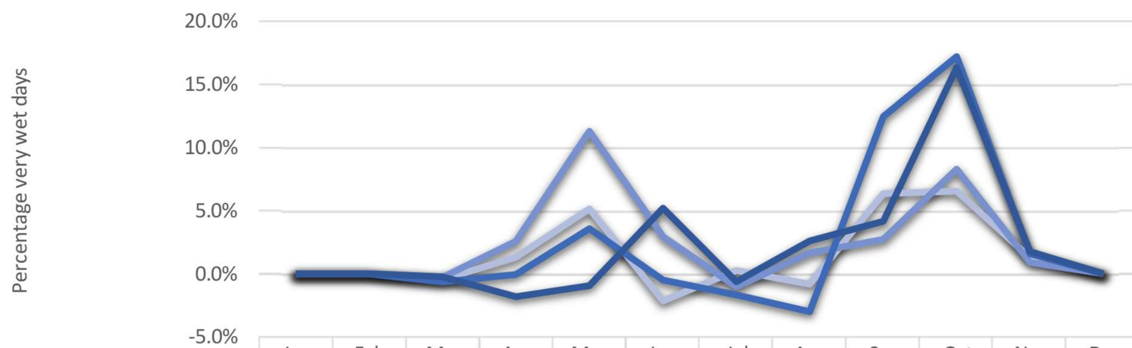
Figure 5-9: Projected change in monthly precipitation at the TKGP in the near and distant future (World Bank, 2020)

5.5.2. Very Wet Days

Figure 5-10 presents the percentage change in precipitation from very wet days at the TKGP in the near (2020- 2039) and distant future (2040-2059) under the low-medium (RCP4.5) and high (RCP8.5) GHG emissions scenarios.

Very wet days are days where the daily precipitation rate exceeds the local 95th percentile of daily precipitation intensity. The higher the percentage, the more rainfall is concentrated with a larger proportion of annual rainfall falling in heavy rainfall events. Conversely, the lower the percentage, the more evenly rainfall is distributed with a lower proportion of annual rainfall falling in heavy rainfall events.

In the near future, precipitation from very wet days is projected to increase by 17% in the low-medium emissions scenario and 29% in the high emissions scenario. In the distant future, precipitation from very wet days is projected to increase by 29% in the low-medium emissions scenario and 26% in the high emissions scenario. In all scenarios, the precipitation from very wet days increases significantly from September to October



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RCP4.5 (2020-2039)	0.0%	0.0%	-0.5%	1.3%	5.1%	-2.2%	0.3%	-0.8%	6.3%	6.5%	1.3%	0.0%
RCP8.5 (2020-2039)	0.0%	0.0%	-0.3%	2.6%	11.3%	3.0%	-1.0%	1.7%	2.7%	8.3%	0.9%	0.0%
RCP4.5 (2040-2059)	0.0%	0.0%	-0.6%	0.0%	3.6%	-0.5%	-1.7%	-3.0%	12.5%	17.2%	1.6%	0.0%
RCP8.5 (2040-2059)	0.0%	0.0%	-0.3%	-1.8%	-0.9%	5.2%	-0.6%	2.6%	4.2%	16.3%	1.8%	0.0%

Figure 5-10: Projected change in precipitation from very wet days at the TKGP in the near and distant future (World Bank, 2020)

5.6. Greenhouse Gas Emissions

The following section presents a broad overview of Ethiopia's current GHG emissions profile.

5.6.1. GHG Emissions by Sector

In 2011, Ethiopia's total GHG emissions was estimated to be 141.1 Mt CO2e (USAID, 2015). As shown in Figure 5-11, Ethiopia's GHG emissions were dominated by the agricultural sector (61.3%), followed by land-use change and forestry (18%), energy sector (16.6%), waste (2.7%), and industrial processes (1.4%).

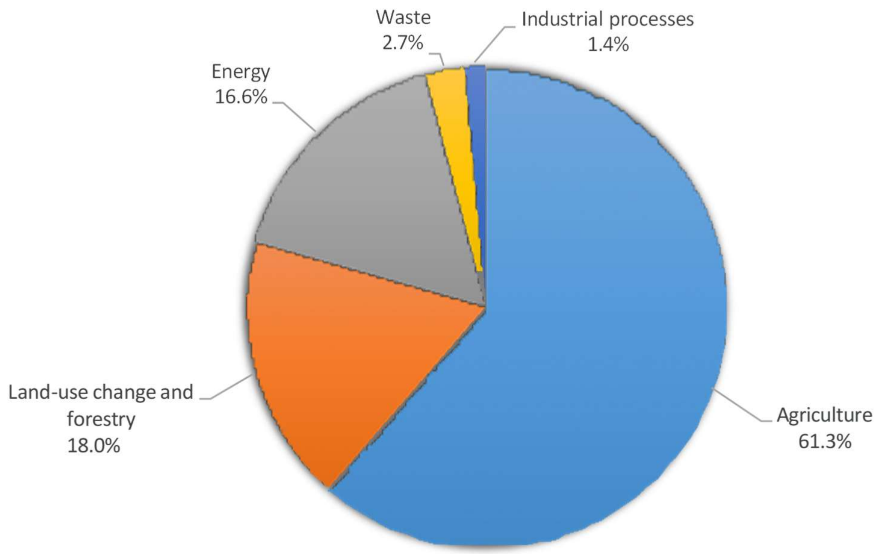


Figure 5-11: Breakdown of Ethiopia's total GHG emissions by sector (USAID, 2015)

Enteric fermentation accounted for the majority of the GHG emissions from agricultural sources (52%), followed by manure left on pasture (37%), and burning of savannah (4%) (USAID, 2015). Ethiopia's agricultural sector was dominated by dry land, subsistence-based, low input/low output farming. Most farmers have less than two hectares of land. In the densely populated highlands, there is a mix of cropland and grazing land, while the eastern parts of the country are mostly used for grazing as these areas are largely unsuitable for crop farming.

There is currently enormous pressure on Ethiopia's forests. The major drivers of deforestation and degradation are forest clearance and land-use conversion for smallholder agricultural expansion, large-scale commercial and state-led initiatives in forest areas, illegal harvesting for fuel wood and charcoal making, growth of human settlements and infrastructure in forest areas, and forest fires.

Biofuels and waste accounted for the majority of GHG emissions from energy sources (93%), followed by fossil fuels (6%), and renewables (1%). It is estimated that 77% of the Ethiopian population does not have access to electricity, and as result are reliant on fuel wood for cooking and heating. Nearly all of Ethiopia's electricity which feeds into the national grid is generated by renewable energy, with the majority coming from hydropower, and to a lesser extent wind and geothermal power.

5.6.2. Change in GHG Emissions over Time

From 1993 to 2011, Ethiopia's GHG emissions grew by 65 Mt CO2e or 86%, with an average annual growth of 4% (USAID, 2015). During this period, the average annual growth of GHG emissions from the sub-sectors was as follows:

- Agriculture (3%)
- Land-use change and forestry (5%)
- Energy (4%)
- Waste (2%)
- Industrial processes (16%)

5.6.3. Carbon Intensity

In 2011, Ethiopia's total population was 89 393 06 (USAID, 2015). The carbon intensity of the population was estimated to be 1.58 t CO2e/capita, which is well below the world average of 6.73 t CO2e/capita.

In the same year, Ethiopia's gross domestic product ("GDP") was US$ 23 billion. The carbon intensity of the economy was estimated to be 6 108 t CO2e/million US$ GDP, which is significantly higher than the world average of 868 t CO2e/million US$ GDP. This indicates that Ethiopia has a relatively carbon intensive economy.

5.7. Geology

5.7.1. Regional Geology

The region lies within the Arabian-Nubian Shield which consists of Upper Proterozoic rocks (up to 800 mega annum (Ma)) and is best described as a granite-greenstone terrain. Additional weakly metamorphosed volcano- sedimentary successions of late Proterozoic age (more than 570 Ma) occur within the terrain.

The western Ethiopian Shield, in which the Tulu Kapi deposit is found lies in the volcano sedimentary sequence dominated by up to 70% of meta-intrusive rocks, ranging from granite to diorite to gabbro in compositions. Most of the gold indications in western Ethiopia are hosted in sheared meta-intrusive rocks.

A major north-northeast oriented shear passes through the Tulu Kapi area and tracks north for more than 100 km where its horsetails to form a series of smaller shears, most which host gold previously recorded by the United Nations Development Programme in the 1970s.

5.7.2. Local Geology

The geology associated with Tulu Kapi consists of rocks ranging from Precambrian to Tertiary in age. The Precambrian rocks consist of gneisses, low-grade volcano-sedimentary rocks with associated mafic to ultramafic intrusions and meta-intrusive rocks.

The following identifiable rock units are diagnostic of the area of the Tulu Kapi deposit (oldest to youngest):

- Basement granitic gneiss
- Meta-sedimentary units
- Birbir Group basement rock
- Quartzites
- Ultramafics
- Mafics and intruded metagabros, metadiorites
- Meta granites
- Syenites

5.7.3. Geology of the Project Area

The geology of an area can affects the soils because of the parent materials and / or rocks that can be found in each location. Sediment was eroded from the mountains and deposited in the valley bottom that resulted from the disintegration of rocks. The composition of the parent material characterizes the mineral composition and the nutrient content of the soil. Geology of the area consists of two major groups of rocks. These are syenite and diorite that are plutonite rock. The diorite rocks forms in the eastern part where as the syenite form the west part. Diorites belong to the basic rocks group and contain high percentage of manganese, magnesium, and calcium. This base rich rock also contains much iron oxide, while syenite is base poor rock.

5.8. Hydrogeology (Groundwater)

5.8.1. Regional Hydrogeology

The hydrogeology of Ethiopia has been mapped at a national scale (1:2 000 000) by the Ethiopian Institute of Geological Surveys (Chernet, 1988). The map shows that the Tulu Kapi region is regarded as a low productivity/aquiclude area and is in Group 4 of the classification – described as a 'localised aquifer with fracture and inter granular permeability (non-carbonate metamorphic rock, granitic intrusive, dolerites).

5.8.2. Local Hydrogeology

As the Project site is located on a hilltop, a surface water and groundwater divide were anticipated. The small springs occur where the topography intersects the water table in the valleys. There is a high degree of weathering of the basement at the site, and this has led to the formation of saprolite (rock weathered to an unconsolidated state), which constitutes a shallow aquifer. This is distinct from the deeper aquifer, which occurs in fractures at considerable depth.

The details of two of the bores suggested the following hydro stratigraphic profile:

- Saprolite (up to 22 m thickness) – degree of saturation unknown
- Weathered rock – up to 6m thick
- Water-bearing fractures in bedrock encountered at 79 and 86 m depth, with static water levels of 8 – 25 m below ground level

In general, the spring water quality is like that of streams but is marginally more acidic and generally more mineralized. Spring water quality is fresher in the rainy season. Overall, the spring water is very fresh, with low mineralisation, indicating rapid circulation and low residence time.

5.9. Hydrology (Surface Water)

5.9.1. Regional River Flow and Base flow

Ethiopia is divided into 12 main river basins, and the mine is situated in the most westerly of these, the Baro- Akobo basin. The Baro-Akobo basin is 76 000 km^2 in area, and forms the headwaters of the West Nile, which flows from Ethiopia to Sudan, and ultimately discharges to the Mediterranean. It rises at 3 000 mamsl at Ilubabor, and the basins lowest point (395 mamsl) is at the Sudanese border (Ethiopian Ministry of Water Resources, 2012).

The Birbir River dominates the region around Tulu Kapi, and flows westwards, then southwards, about 8 km from the Project site. Table 5-7 presents a summary of the minimum monthly flows of the Birbir River at a monitoring station downstream of the Project site. The catchment to this station is approximately 1 563 km^2. It is estimated that the catchment to the location of the proposed pump station is 890 km^2 (Knight Piésold, 2020b). The minimum flow rates at this location were calculated by applying a factor 0.57 on the flows recorded at the monitoring station.

Table 5-7: Minimum monthly flow rates in the Birbir River (Knight Piésold, 2020b[5])

Month	Unit	Monitoring station (1 563 m^2 catchment)	Monitoring station (890 m^2 catchment)
January	m^3/s	11.7	6.7
February	m^3/s	8.8	5.0
March	m^3/s	7.2	4.1
April	m^3/s	6.2	3.5
May	m^3/s	6.4	3.6
June	m^3/s	12.6	7.2
July	m^3/s	25.6	14.6
August	m^3/s	45.2	24.7
September	m^3/s	57.7	32.9
October	m^3/s	26.9	15.3
November	m^3/s	19.4	11.0
December	m^3/s	13.9	7.9

Figure 5-12 presents a comparison of minimum flows in the Birbir River and average rainfall collected from three weather monitoring stations at Aira, Gimbi and Alghe. It can be seen that there is a lag in the flow of the Birbir River when compared to rainfall within the catchment area.

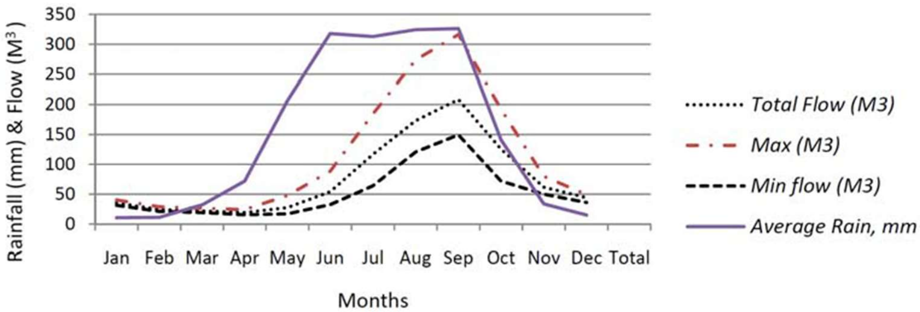


Figure 5-12: Comparison on minimum flows in the Birbir River and average rainfall (JEMA Consulting International and SRK, 2011)

5.9.2. Local Stream Flow and Quality

The TKGP is located on a ridge forming a watershed which drains north and south (Knight Piésold, 2020a). Drainage to the north is towards the Gurach and Kersa Rivers which are sub-tributaries of the Birbir River. Drainage to the south is via the Chalte, Kumbo and Sarere Rivers which are sub-tributaries to the Baro and Blue Nile Rivers. The streams in the area are perennial but reduce to very low flow rates in the dry season.

Table 5-8 presents the location of stream flow and water quality monitoring points within the Project area.

Table 5-8: Surface water monitoring locations

Location	Stream/River	Description of location
SW01	Churi	Downstream of proposed tailings area
SW02	Churi	Downstream of SW01
SW03	Birbir	Upstream of mine stream sub-catchments
SW04	Guracho	Downstream of pit
SW05	Gadamso	Downstream of stream confluence
SW06	Gadamso	Catchment monitoring point

Weekly stream height monitoring was carried out in 2014, with the results indicating that these streams/rivers are perennial and respond seasonally in a similar (perennial) pattern. A stage-flow relationship for the above monitoring locations is in development but will require extensive monitoring of river flows. The results of the local stream minerals indicate that the water is fresh (Electrical Conductivity ("EC") values 40 – 90 uS/cm), and the overall level of minerals are low and that it is slightly acidic. Low nitrate and chloride values reflect a low intensity of agricultural use.

5.9.3. Water Quality

5.9.3.1. Sample Locations and Dates

An initial round of water quality samples was taken in 2011 by SRK Consulting and JEMA. Samples were taken in both the dry season and the wet season from springs, boreholes, and surface water sampling sites.

A second round of wet season water quality samples were taken by Golder, together with GEDAG, in 2018. Where possible, samples were taken from the same sampling points used in 2011. There were however some sampling points that could not be sampled as the springs were dry or the boreholes used for sampling in 2011 had been filled in. The location of these sampling points is shown in Figure 5-13 below

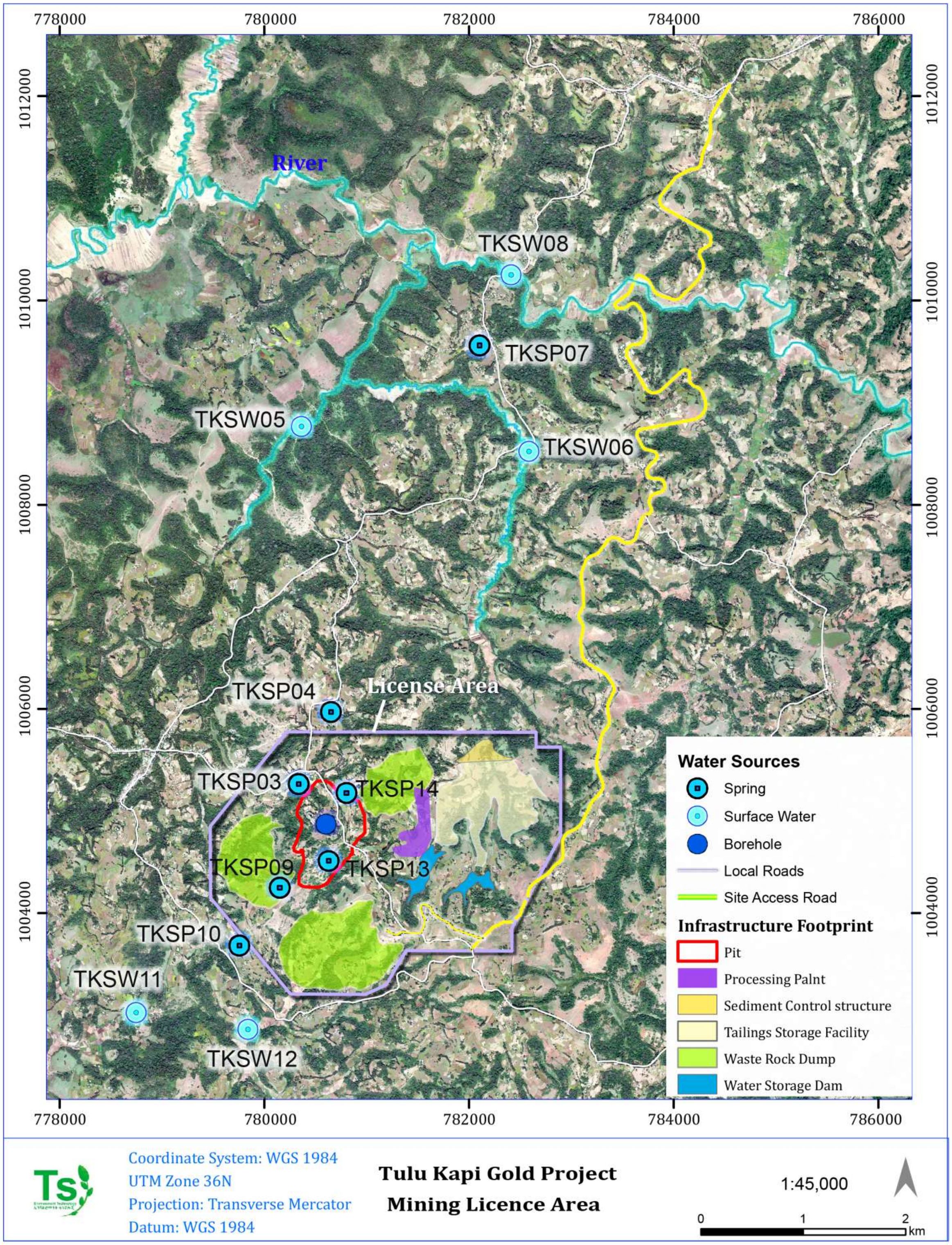


Figure 5-13: Water sampling locations

5.9.4. Water Use

Water use was assessed along key perennial streams and rivers in the Project area. The list of the rivers/streams is summarized in Table 5-9 below.

Table 5-9: Watercourses covered by the Tulu Kapi monitoring programme

Rivers/Streams	Remark
Birbir	Used for cattle watering, irrigation, bathing and swimming
racho stream/Churi	Tributaries of Birbir draining to the north of Tulu Kapi site. Water uses are cattle watering, irrigation, washing and bathing. There is a water mill along Churi stream
Gojo	
Karsa	
Chalte	Tributary of Birbir river draining to the south of Tulu Kapi site. Mainly used for cattle watering, washing and irrigation.
Arera stream	Tributary of Birbir river draining to the south of Tulu Kapi. Mainly used for cattle watering, washing and bathing; domestic purposes and irrigation
Gadamsa stream	The name of Chalte and Arera downstream

Table 5-10 presents the water uses observed along the major water courses draining the Tulu Kapi area.

Table 5-10: Water uses observed along major watercourses draining the Tulu Kapi area

Stream	Point/Malka	Water use	Number of households or	Easting (m)	Northing (m)	Altitude (m)	Remark
Arera	Aba Abetu	Domestic	300	779170	1005216	1 620	Protected spring headwaters of Arera
		Washing & bathing	100				
	Point 1 Gomo/Bulb ul	Domestic	25	779660	1004306	1 596	Firewood collection from trees along the stream. Water use is from springs that emerge from valley sides rather than directly from the stream
		Washing	39				
		Cattle watering	60				
		Irrigation	20	779438	1003728	1 581	
	Point 2	Cattle watering	no count	779508	1003460	1 562	Major trail crossing the stream

Strea	Point	Wate	Numb hous s or c	Easti g (m)	North g (m)	Altitu	Rema
				782147	1005540	1 601	The stream discharge at this point was estimated to be 10ℓ /sec
	Point 3	Cattle watering	no count	779321	1003012	1 532	Fire wood collection all along the stream
Chalte	Malka Turi	Washing	20	779296	1002895	1 540	Immediately downstream of the Chalte and Arera confluence
		Cattle watering	100				
		Fire wood	no count				
		Bathing	20				
	Laga Bolo	Domestic	45	781387	1002972	1 647	Protected spring immediate adjacent to stream. Head waters of Chalte stream
		Washing & bathing	45				
		Cattle watering	150				
	Hursa 1	Washing & bathing	10	780385	1003747	1 595	Spring emerging from valley side is used for domestic consumption
		Cattle watering					
		Irrigation					
		Domestic	10				
	Hursa 2	Washing & bathing	11	780177	1003365	1 577	Spring emerging from valley side is used for domestic consumption
		Cattle watering					
		Domestic	11				
	ama-e	Washing & bathing	16	780592	1003440	1 594	Spring emerging from valley side is used for domestic consumption
		Cattle watering					
		Irrigation					

Stream	Point/Malka	Water use	Number of households or	Easting (m)	Northing (m)	Altitude (m)	Remark
		Domestic	16				
	Adami	Irrigation	24	779686	1002412	1 555	
		Cattle watering	no count				
		Washing & bathing	no count				
	Bildime	Domestic	4	780061	1002756	1 560	
		Washing & bathing	no count				
		Cattle watering	100				
		Irrigation	no count				
	Malka Hora	Irrigation	100	778007	1002513	1 529	Irrigated maize land over large area both upstream and downstream. Major trail and wooden bridge.
		Washing & bathing	8				
		Domestic use	8				
Churi / Gurach	Malka Gobana	Domestic	7	782687	1005853	1 594	Fire wood collection all along the stream
		Washing	7				
		Cattle watering	600				
		Irrigation	28				
		Washing	25				
Gojo stream	Malka Aba Fite	Cattle watering	100	782147	1005540	1 601	Bathing and washing slightly down stream
		Bathing	25				
		Domestic	12				
	Malka Dildila	Washing	12	782202	1006424	1 578	Fire wood collection all along the stream
		Cattle watering	400				
		Irrigation	24				

Stream	Point/Malka	Water use	Number of households or cattle	Easting (m)	Northing (m)	Altitude (m)	Remark
		Washing	no count				
	Malka Churi	Cattle watering	200	782555	1008588	1 544	Coffee plant nursery 2 km up stream of this point, there is washing & bathing point
		Irrigation	no count				
		Bathing	no count				
		Washing	no count				
Birbir River	Malka Aba Korome	Cattle watering	150	782423	1010232	1 499	
		Bathing/Swimming	no count				
		Washing	no count				
		Cattle watering	250	779092	1010865	1 483	Downstream of confluence of Churi and Birbir Rivers
		Irrigation	200				
		Bathing/Swimming	no count				
Karsa Stream	Malka Karsa Horo	Washing	15	779494	1006158	1 534	Maize, sugar cane and coffee nursery
		Cattle watering	300				
		Bathing	15				
	Chorito 1	Irrigation	25	779891	1008033	1 560	
		Washing	no count				
	Chorito 2	Cattle watering	300	779960	1008406	1 560	Irrigation upstream of this point & downstream of Chorito 1
	Malka Guda	Irrigation	no count				
		Bathing	no count				
	Chorito 3	Washing	no count	780513	1008906	1 543	Fire wood collection along the stream
		Cattle watering	200				
		Bathing	no count				

Stream	Point/Malka	Water use	Number of households or cattle	Easting (m)	Northing (m)	Altitude (m)	Remark
Chalte stream	Malka Chalte 2	Domestic	5	778699	1003036	1 530	Fire wood collection along the stream
		Washing	20				
		Cattle watering	100				
		Irrigation	50				
		Bathing	no count				

5.9.5. Comparison of Water Quality Guidelines

The water samples from the once off sampling exercise undertaken in September 2018 were evaluated in terms of the following parameters:

- Physio-chemical: Total alkalinity as $CaCO_3$, electrical conductivity, pH, total dissolved solids ("TDS"), and dissolved oxygen ("DO").
- Major dissolved ions: Calcium, magnesium, sodium, sulphate, chloride, fluoride, and nitrate as NO_3.
- Inorganics and trace metals: Aluminium, arsenic, cadmium, chromium, copper, iron, potassium, lead, mercury, and nickel.

The results from the laboratory analysis were then compared against local and international standards – see Table 5-11 and Table 5-12. Considering that the water use in the area is predominantly for domestic use, the Ethiopian Drinking Water Specifications (ESA, 2013), the WHO Drinking Water Guidelines (WHO, 2017) and relevant IFC standards, as well as the South African Water Quality Guidelines for domestic use (DWA, 1996) were used to assess the fitness for use of the water.

Based on the above results of the water quality analysis on the once off sampling undertaken in September 2018, the following is apparent in terms of the baseline assessment:

- Except for TKSP04, the pH of the spring water samples was below the Ethiopian and WHO guideline of
  6.5 And can therefore be described as slightly neutral. As the values are only marginally below the
  Threshold, this is not a major concern
- The total alkalinity of TKBH01 (216 mg/ℓ) exceeds the Ethiopian guideline of 200 mg/ℓ. As alkalinity is used as an indication of the capacity of water to resist changes in pH that would make water more acidic,
  This exceedance is also not considered to be a major concern
- The dissolved arsenic values in TKBH01 (10.1 µg/ℓ) exceeds the Ethiopian, WHO and South African guideline of 10 µg/ℓ. As the exceedance is only marginally above the threshold, this is not a major concern. Further to this, the threshold value of 10 µg/ℓ is relatively conservative
- The total dissolved iron in TKBH01 (5 733 mg/ℓ) exceeds the Ethiopian and South African guideline values of 300 mg/ℓ and 2 000 mg/ℓ respectively. Exceedance of these threshold values is likely to result in pronounced aesthetic effects, such as taste, and problems with plumbing. Slight health effects (gastric complaints such as diarrhoea) can also be expected in young children, and sensitive individuals
- The dissolved potassium in TKBH01 (2.9 mg/ℓ) exceeds the Ethiopian guideline value of 1.5 mg/ℓ. Health problems are only expected with levels more than 100 mg/ℓ for people with renal problems

Table 5-11: Summary of the water quality results from the surface water (SW) and borehole (BH) samples taken in 2018

Water quality parameter	Units	Standards				Surface water and groundwater monitoring sites					
		Ethiopian	WHO	IFC	SA Guidelines	TKSW02	TKSW03	TKSW04	TKSW05	TKSW06	TKBH01
Physio-chemical											
Total alkalinity as $CaCO_3$	mg/ℓ	*200*	*500*	*n/a*	*n/a*	40	29	18	34	44	216
Electrical Conductivity @25°C*	mS/m	*n/a*	*n/a*	*n/a*	*70*	8	4	2	7	10	39
pH	pH units	*6.5 – 8.5*	*6.5 - 8.5*	*6 .0- 9.0*	*6 .0- 9.0*	7.49 (7.37)	7.38 (7.42)	7.1 (7.43)	7.4 (7.42)	7.53 (7.45)	7.06 (7.23)
Total Dissolved Solids	mg/ℓ	*1 000*	*n/a*	*1 000*	*450*	87	103	94	107	89	269
Dissolved oxygen*	mg/ℓ	*n/a*	*n/a*	*n/a*	*n/a*	7.67	7.27	7.08	7.61	-	1.61
Major Dissolved Ions											
Dissolved Calcium	mg/ℓ	*75*	*n/a*	*n/a*	*80*	7.7	6.4	3.4	6.6	8.9	59.2
Dissolved Magnesium	mg/ℓ	*50*	*n/a*	*n/a*	*30*	4.9	2.5	1	3.3	4.4	6.8
Dissolved Sodium	mg/ℓ	*200*	*200*	*n/a*	*100*	4.1	3.5	4	4.5	4.6	16.4
Sulphate	mg/ℓ	*250*	*250*	*n/a*	*n/a*	2.2	2.3	1.9	2.1	2.5	14
Chloride	mg/ℓ	*250*	*250*	*n/a*	*n/a*	2.2	2.2	2.2	2.5	2.3	4
Fluoride	mg/ℓ	*1.5*	*1.5*	*1*	*n/a*	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Nitrate as NO_3	mg/ℓ	*50*	*50*	*n/a*	*6*	2.2	1.4	2.1	1.9	1.4	1.2
Inorganics and Trace Metals (Dissolved)											
Dissolved Aluminium	µg/ℓ	*200*	*100*	*n/a*	*n/a*	<20	<20	<20	<20	<20	<20
Dissolved Arsenic	µg/ℓ	*10*	*10*	*100*	*10*	<2.5	<2.5	<2.5	<2.5	<2.5	10.1

Water quality parameter	Units	Standards				Surface water and groundwater monitoring sites					
		Ethiopian	WHO	IFC	SA Guide lines	TKSW02	TKSW03	TKSW04	TKSW05	TKSW06	TKBH01
Dissolved Cadmium	µg/ℓ	*3*	*3*	*50*	*0.25*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Dissolved Chromium	µg/ℓ	*50*	*50*	*100*	*12*	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Dissolved Copper	µg/ℓ	*2 000*	*2 000*	*300*	*0.8*	<7	<7	<7	<7	<7	<7
Total Dissolved Iron	µg/ℓ	*300*	*n/a*	*2 000*	*n/a*	<20	73	65	27	47	5 733
Dissolved Potassium	mg/ℓ	*1.5*	*n/a*	*n/a*	*50*	0.8	0.8	0.9	<0.1	0.8	2.9
Dissolved Lead	µg/ℓ	*10*	*10*	*200*	*5*	<5	<5	<5	<5	<5	<5
Dissolved Mercury	µg/ℓ	*1*	*6*	*2*	*0.4*	<1	<1	<1	<1	<1	<1
Dissolved Nickel	µg/ℓ	*n/a*	*70*	*n/a*	*n/a*	<2	<2	<2	<2	<2	<2

Table 5-12: Summary of the water quality results from the spring water (SP) taken in 2018

Water quality parameter	Units	Standards				Surface water and groundwater monitoring sites						
		Ethiopian	WHO	IFC	SA Guide lines	TKSP02	TKSP04	TKSP06	TKSP07	TKSP08	TKSP09	TKSP10
Physio-chemical												
Total alkalinity as $CaCO_3$	mg/ℓ	*200*	*500*	*n/a*	*n/a*	15	41	14	12	9	31	8
Electrical Conductivity @25°C*	mS/m	*n/a*	*n/a*	*n/a*	*70*	10	9	3	4	7	7	10
pH	pH units	*6.5 – 8.5*	*6.5 - 8.5*	*6 .0- 9.0*	*6 .0- 9.0*	6.29 (6.61)	6.85 (6.38)	6.4 (6.04)	6.26 (5.58)	5.69 (5.98)	6.37 (6.09)	5.71 (6.12)
Total Dissolved Solids	mg/ℓ	*1 000*	*n/a*	*1 000*	*450*	94	119	76	64	97	89	87
Dissolved oxygen*	mg/ℓ	*n/a*	*n/a*	*n/a*	*n/a*	5.98	5.01	6.01	6.02	5.48	4.86	4.28

Water quality parameter	Units	Standards				Surface water and groundwater monitoring sites						
		Ethiopian	WHO	IFC	SA Guidelines	TKSP02	TKSP04	TKSP06	TKSP07	TKSP08	TKSP09	TKSP10
Major Dissolved Ions												
Dissolved Calcium	mg/ℓ	*75*	*n/a*	*n/a*	*80*	7.2	9.2	2.3	3.2	4.8	5.2	6.3
Dissolved Magnesium	mg/ℓ	*50*	*n/a*	*n/a*	*30*	2.3	4.2	0.6	0.9	1.4	2	1.7
Dissolved Sodium	mg/ℓ	*200*	*200*	*n/a*	*100*	7.4	5.9	5.3	4.4	4.6	5.9	6.6
Sulphate	mg/ℓ	*250*	*250*	*n/a*	*n/a*	2.8	<0.5	3.8	1.7	<0.5	2.1	3.6
Chloride	mg/ℓ	*250*	*250*	*n/a*	*n/a*	6.8	2.3	1.8	1.7	3.4	3.8	6.9
Fluoride	mg/ℓ	*1.5*	*1.5*	*1*	*n/a*	<0.3	<0.3	0.6	<0.3	<0.3	<0.3	<0.3
Nitrate as NO3	mg/ℓ	*50*	*50*	*n/a*	*6*	17.7	9.6	3.9	7.7	21.1	<0.2	27.5
Inorganics and Trace Metals (Dissolved)												
Dissolved Aluminium	µg/ℓ	*200*	*100*	*n/a*	*n/a*	<20	27	<20	<20	<20	<20	<20
Dissolved Arsenic	µg/ℓ	*10*	*10*	*100*	*10*	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Dissolved Cadmium	µg/ℓ	*3*	*3*	*50*	*0.25*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Dissolved Chromium	µg/ℓ	*50*	*50*	*100*	*12*	<1.5	2.7	<1.5	<1.5	<1.5	<1.5	<1.5
Dissolved Copper	µg/ℓ	*2 000*	*2 000*	*300*	*0.8*	<7	9	<7	11	<7	<7	17
Total Dissolved Iron	µg/ℓ	*300*	*n/a*	*2 000*	*n/a*	<20	79	<20	<20	<20	<20	<20
Dissolved Potassium	mg/ℓ	*1.5*	*n/a*	*n/a*	*50*	2.2	0.8	0.7	1.8	2.5	0.8	4.5
Dissolved Lead	µg/ℓ	*10*	*10*	*200*	*5*	<5	<5	<5	<5	<5	<5	<5
Dissolved Mercury	µg/ℓ	*1*	*6*	*2*	*0.4*	<1	<1	<1	<1	<1	<1	<1

5.9.6. Geochemistry

The guideline comparison suggests that some metals may be naturally elevated in the water around Tulu Kapi. The chemical signature of the Tulu Kapi monitoring samples is generally Ca-HCO_3 type water. This is characteristic of rainfall and is expected given the high rainfall of the area. The results also suggest a relatively short retention time of rainfall in soils.

Comparison of cadmium concentrations in samples from different sources suggests that cadmium concentrations are relatively higher in groundwater (boreholes and springs) than in surface water samples. Surface waters have a higher pH (approximately 7) than groundwater (approximately 5.5). At lower pH, cadmium is less likely to be bound to colloidal material such as iron hydroxide which accounts for its higher concentration in groundwater.

Lead is expected to behave similarly to cadmium but is higher in surface water than in groundwater. The broad range of higher lead concentrations appears consistent with (anthropogenic) contamination. Mercury concentrations are also higher in surface water samples. This may indicate contamination from sources such as artisanal mining.

5.9.7. Affected Catchments and Water Use Points

The proposed infrastructure of the TKGP is situated in the headwaters of three local river catchments, as summarised in the Table 5-13 below.

Table 5-13: Catchments in which Tulu Kapi infrastructure is situated

	Infrastructure	Downstream community water uses points
Gojo	Ore Processing Plant, permanent camp, ROM pad, North WRD, northern pit, water storage dams, TSF	Malka Dildila, Malka Churi, Malka Aba Fite
Arera	North WRD	Arera 1, 2 and 3
Chalte	Explosives magazines, South WRD and Haul Toad A Complex	Hurse 1, 2, Dhama-e, Bildime, Malka Turi, Malka Chalte 2

The main mine pit lies on the divide between the Chalte, Arera and Gojo catchments. The Arera River is a tributary of the Chalte River and water use point Malka Chalte 2 lies immediately downstream of the confluence.

5.9.8. Water Balance

In 2020, the water balance of the TKGP was updated to determine (Knight Piésold, 2020a):

- The water requirements of the Ore Processing Plant
- The volume of storm water runoff and excess slurry that would report to the TSF decant pond
- If the TSF will have sufficient capacity to meet the water requirements of the Ore Processing Plant
- If WD1 will have sufficient capacity to supplement the supply of water from the TSF to the Ore Processing Plant

A schematic presentation of the updated water balance is presented in Figure 5-14.

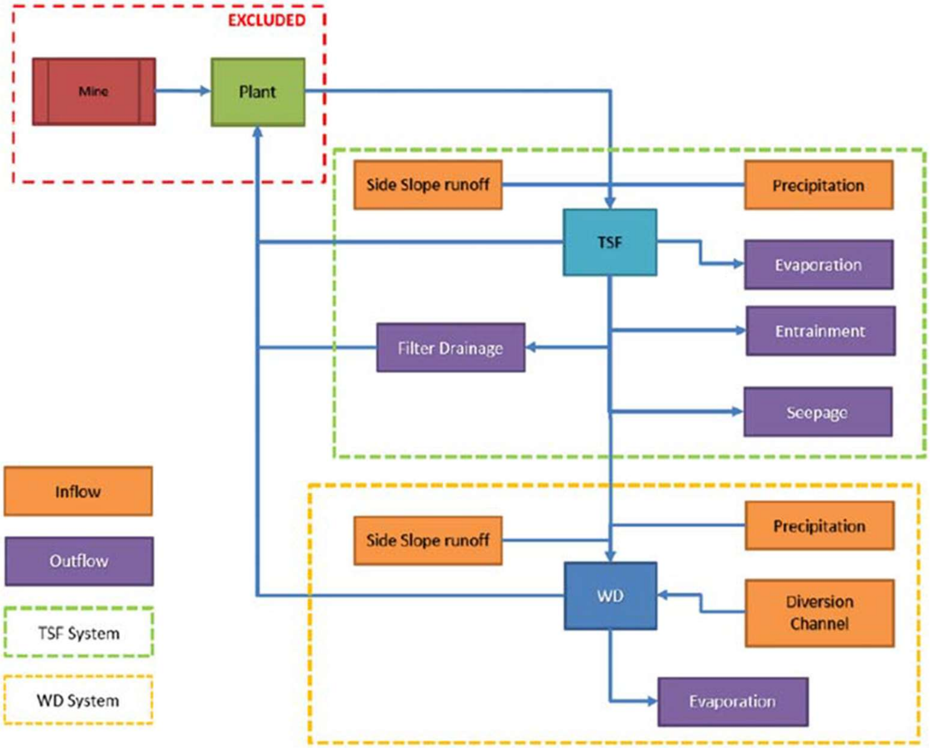


Figure 5-14: Schematic diagram of the updated water balance (Knight Piésold, 2020b)

The total water requirements of the Ore Processing Plant were determined by Lycopodium Minerals Pty Ltd ("Lycopodium"), who have been appointed by TKGM as the engineering, procurement, and construction contractor for the Ore Processing Plant. In determining the water requirements of the plant, the following three scenarios were developed:

1) **Oxide:** processing of oxide ore
2) **Shallow fresh:** processing of shallow fresh ore
3) **Deep fresh:** processing of deep fresh ore

Table 5-14 presents a summary of the water requirements in the three scenarios. It can be seen that oxide is the worst case scenario as the average decant return from the TSF is the lowest of the three scenarios (194 t/hr when compared to 213 t/hr and 209 t/hr from the shallow fresh ore and deep fresh ore, respectively) and as a result, the additional raw water requirements are the greatest (200 t/hr when compared to 138 t/hr and 126 t/hr).

For a more detailed breakdown of the water balance of each of the three scenarios see Figure 5-15, and Figure 5-16 below.

Table 5-14: Water balances in the three scenarios

Inputs and outputs	Oxide	Shallow Fresh	Deep Fresh
	Avg. flow (t/hr)	Avg. flow (t/hr)	Avg. flow (t/hr)
Water in mill feed	14	14	12
Average decant return from the TSF	194	213	209
Sub-total	***208***	***227***	***221***
Water required into tailings	388	388	336
Water required for dust suppression and crushing service points	15	15	15
Other water requirements at the plant	5	5	5
Sub-total	***408***	***408***	***356***
Additional raw water requirements of the plant	**200**	**138**	**126**
Water required for potable water at the mine	2	2	2
Water required for mine services and dust suppression at the mine	10	10	10
Other water requirements at the mine	5	5	5
Sub-total	***17***	***17***	***17***
Additional raw water requirements of the plant and the mine	**217**	**175**	**143**

Knight Piésold Ltd (Knight Piésold) were appointed by TKGM to develop the preliminary design for the TSF and WD1 (Knight Piésold, 2020b). As part of this appointment, Knight Piésold also developed an updated water balance to determine if the TSF and WD1 will have sufficient capacity to meet the raw and processing water requirements of the Ore Processing Plant.

1.1.1.1.1 Parameters and Assumptions

Table 5-15 presents a summary of key parameters used in developing the water balance. For a complete list of the parameters, see APPENDIX L.

Table 5-15: Water balance parameters (Knight Piésold, 2020b)

Area	Parameter	Unit	Value
Ore Processing Plant	Production	Kt/month	177
	Required pump rate to plant at commission	m^3/hr	394
TSF	Commissioning pool level	m^3	186 240
	Minimum pool volume	m^3	10 000
	Fraction of water retained in tailings	%	38
	Volume of material (solids + water)	m^3/month	352 667
	Volume of water	m^3/month	289 333
Water Storage Dam	Volume	m^3	509 000
	Minimum level	m^3	10 000
	Average decant rate to TSF	m^3/hr	194
	Average decant rate to plant	m^3/hr	200

In developing the water balance, several assumptions were also made (Knight Piésold, 2020). This includes:

- During the commissioning of the Ore Processing Plant (assumed to be 40-days), 394 m3/hr will be required with 200 m3/hr supplied by WD1 and the remaining 194 m3/hr by the TSF

- Prior to the deposition of tailings, all water above 186 000 m3 in the TSF will be pumped to WD1
- Upon deposition of the slurry to the tailings beach, the tailings are expected to settle at an initial dry density of 1.08 t/m3 corresponding to a void ratio of 1.6 resulting in the almost immediate release of 62% of the slurry water, most of which will report directly to the decant pool
- The subsequent consolidation of the tailings over time to an average void ratio of 1.1 and a dry density of 1.33 t/m^3 is not expected to result in the release of additional water to the decant pond. Slurry water released in this process is expected to be lost to either seepage or evaporation, with some water retained in interstitial storage
- Water will be captured in the TSF and WD1 from June 2021 until commissioning in October 2021
- WD1 will be available from June 2021
- WD2 and the diversion channels south of the TSF will only available from February 2022
- The minimum TSF volume will be 10 000 m^3
- The 1:100 year storm was applied in the worst month, which is August. For a period of 10 days before and after the storm, the daily rainfall was reduced by 50%. This is a conservative approach and results in a slightly higher monthly rainfall for the storm event. Further probabilistic analysis can be done in the detail design phase. Furthermore, a start-up delay of 2 days, after a storm, was applied. No pumping can be done during these two days
- Pumping from the TSF was prioritised to reduce the TSF pool volume as much as possible to achieve maximum consolidation
- A minimum volume of 10 000 m^3 was applied to WD1
- Pumping from the TSF to the Ore Processing Plant was set as follows:
    - No pumping if the TSF pool is below 10 000 m3
    - Average pumping when the pool is between 10 000 m3 and the maximum pool volume
    - Maximum pump rate when the TSF pool is above the maximum pool volume
- Several analyses were run with different maximum TSF pool volumes (20 000 m3, 50 000 m3, and 100 000 m3)
- WD1 was supplementing the pumping from the TSF:
    - If the TSF was at maximum pump rate, no water was being pumped from WD1
    - If the TSF was pumping at the average pump rate, WD1 was also pumping at the average rate
    - If no water was being pumped from the TSF, the maximum pump rate was applied to WD1
- WD1 overflowed to the environment when it exceeded its maximum capacity

5.9.9. Findings

Figure 5-15 presents the volumes of water in the TSF pool and WD1 at a maximum TSF pool volume of 20 000 m^3. Note that:

- There will be overflow from WD1 in years 2, 3 and 4. The volume of water spilled to the environment is shown on the secondary axis
- In the later years, volume in WD1 does not reach the maximum. This is largely because seepage and evaporation from the TSF increases over time, and therefore the Ore Processing Plant relies more on WD1 in the later stages

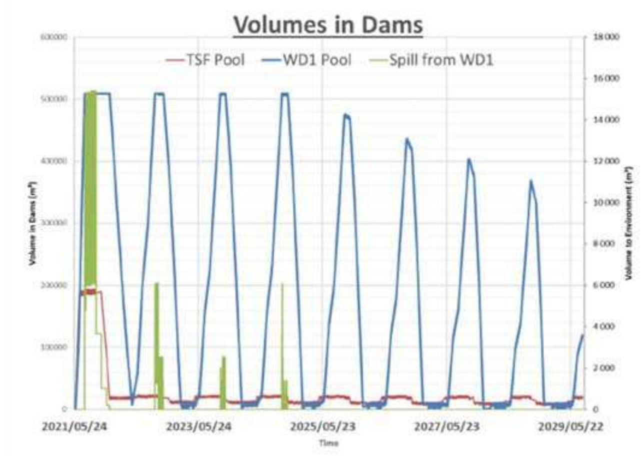


Figure 5-15: Volumes in dams at a maximum TSF pool volume of 20 000 m^3 (Knight Piésold, 2020b)

Figure 5-16 presents the volumes of water in the TSF pool and WD1 at a maximum TSF pool volume of 50 000 m^3. Note that:

- There is reduction in the overflow from WD1 in years 2, 3 and 4
- There is a slight increase in the utilisation of water from WD1

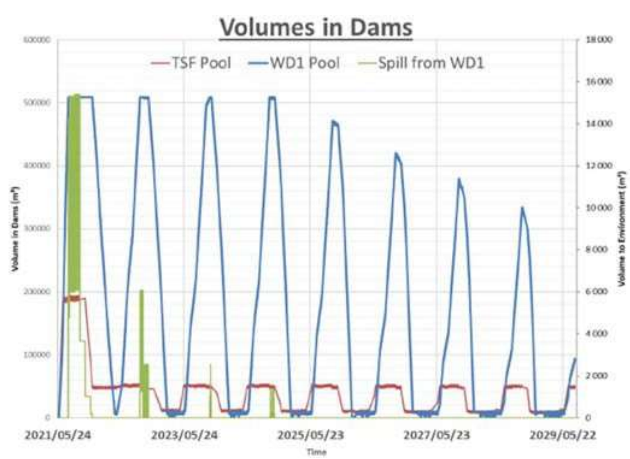


Figure 5-16: Volumes in dams at a maximum TSF Pool volume of 50 000 m^3 (Knight Piésold, 2020b)

Figure 5-17 presents the volumes of water in the TSF pool and WD1 at a maximum TSF pool volume of 100 000 m^3. Note that:

- There are no longer spillages from WD1 in years 3 and 4
- There is a significant increase in the utilisation of water from WD1 Volumes in the TSF and WD1 reach the lower limit of 10 000 m^3 in the dry periods

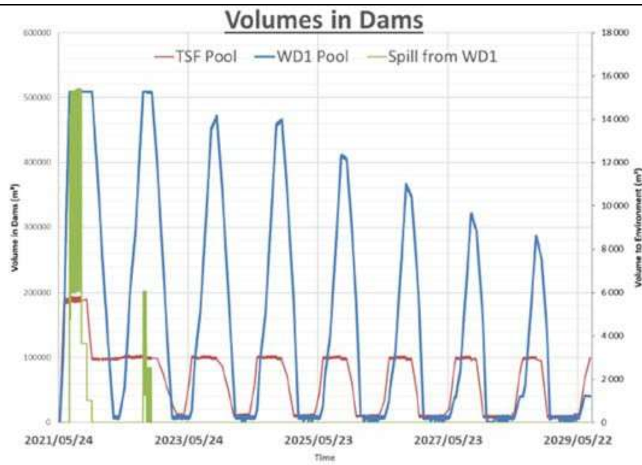


Figure 5-17: Volumes in dams at a maximum TSF Pool volume of 100 000 m^3 (Knight Piésold, 2020b)

Figure 5-18 presents the volumes of water in the TSF pool and WD1 at a maximum TSF pool volume of 100 000 m^3 with a 1:100 year storm event. Note that:

- The 1:100 year storm event was applied in August 2022. August was selected as it is the month with the highest rainfall
- The TSF pool volume increased to 240 000 m3 following the storm. This raises the water level to 1 619 mamsl, which is only 0.4 m below the starter wall spillway level
- The TSF pool will only be within a few metres of the TSF wall
- There will be a significant spillage from WD1 following the storm

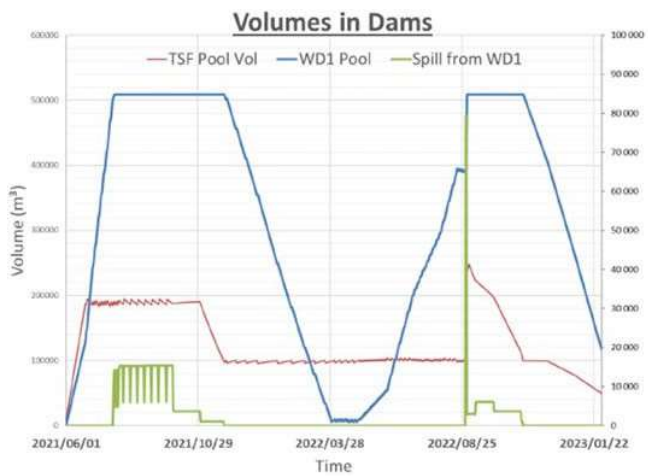


Figure 5-18: Volumes in dams at a maximum TSF Pool volume of 100 000 m^3 with a storm event (Knight Piésold, 2020b)

1.1.1.2 Conclusions

- Prior to the deposition of tailings, the TSF can store a significant volume of water. This volume should however be limited to approximately 186 000 m3 to limit the effects on consolidation of the deposited
  Tailings
- Although storing water on the TSF will reduce the make-up water requirements, the capacity of the TSF and future stability during upstream raising will be negatively affected as the pool sits close to the TSF
  Wall at relatively low volumes. The storage volume should therefore be limited to below 100 000 m3. This value could potentially be increased in the later stages of the TSF life as the pool moves towards the south

- If the TSF is always pumped to its minimum level, the water in WD1 is often not utilised and overflow to the environment occurs regularly
- Pool and freeboard management will be critical at stages when the tailings approach the crest of the embankment, while the next phase of embankment has not been constructed yet. It is therefore
- important to finish construction of the next phase of embankment before the wet season starts
- During average rain conditions, the TSF and WD1 will be able to supply 100 % of the water requirements of the Ore Processing Plant, but for periods in the dry season, additional make-up water will have to be sourced from other sources

Option 1: Determine if there is sufficient surface water runoff available from the Project site to provide a reliable process make-up water supply for the LOM. The following infrastructure was included in this option:

- TSF
- Two water storage dams (WD1 and WD2)
- Two storm water diversion channels
- Three sediment control ponds downstream of the WRDs.
- Note that the open pits were not considered in this option

Option 2: Assess additional water sources to reduce project risk if water shortfalls are forecast for Option 1. This option considered abstraction from the Birbir River, approximately 5 km from the Project site, as the base case.

Note that groundwater resources were not considered in this assessment as they are not expected to be of sufficient yield to fully meet the process demand over the LOM.

Scheduling Assumptions

For modelling purposes, the following scheduling assumptions were made:

- Option 1:
  - Surface water runoff collection within the TSF, water storage dams, and sediment control ponds, starts on 1 June 2021
  - One full year of runoff will be collected prior to the commissioning of the Ore Processing Plant
- Option 2:
  - Only surface water runoff collected in the TSF, WD1, and the WD1 storm water diversion channel were included in this option. Runoff collected in WD2, WD2 storm water diversion channel, and the three sediment control ponds was therefore excluded from this option
- Both options:
  - Seepage interception downstream of the TSF is assumed to return 10 ℓ/s from the 1st November
  - 2021, one month after the commissioning of the ore processing process plant
  - Return from the TSF to the Ore Processing Plant was set to start when the supernatant pond first reaches a volume exceeding 100 000 m3. After this point, decant return will occur unless the supernatant pond volume is less than the minimum pond volume of 10 000 m3
  - The TSF will be used to collect water prior to commissioning, with runoff pumped from the TSF basin to WD1

Storage Assumptions

Table 5-16presents a summary of the storage capacities of the infrastructure included in Option 1.

Table 5-16: Storage capacity of infrastructure included in Option 1 (Knight Piésold, 2020b)

Description	WD1	WD2	TSF	Sediment control pond (North WRD)	Sediment control pond (West WRD)	Sediment control pond (South WRD)
Spillway invert (RL m)	1 656	1 668	1 622	1 606.8	1 597.0	1 569.8
Max. supply volume (m^3)	509 000	665 000	2 600 000	27 700	67 000	85 200
Min. pumping level (RL m)	1 635	1 647	1 593.2	1 599.8	1 592.0	1 563.8
Abstraction rate to WD1 (ℓ/s)	40	40	40	40	40	40

Table 5-17 presents a summary of the storage capacities of the infrastructure included in Option 2.

Table 5-17: Storage capacity of infrastructure included in Option 2 (Knight Piésold, 2020b)

Description	WD1	TSF
Spillway invert (RL m)	1 656	1 622
Max. supply volume (m^3)	509 000	2 600 000
Min. pumping level (RL m)	1 635	1 593.2
Abstraction rate to WD1 (ℓ/s)	40	40

Results

Table 5-18 presents a summary of the water modelling results for Option 1 based on 17 runs for two-year precipitation scenarios. It should be noted that a 20-year annual recurrence interval dry year was included in the precipitation scenarios (i.e. 1997 – 1998).

The results of the modelling indicate that a water shortfall is likely in 13 of the 17 two-year precipitation scenarios (or 76%), and that periods of two (2) to six (6) weeks without full production would be likely. There is therefore a significant risk of water shortfalls during the first year of operation or post commissioning, and an external water source is recommended by Knight Piésold (2020b).

Table 5-18: Water balance model results for Option 1 (Knight Piésold, 2020b)

Rainfall years	Average catchment runoff coefficient	Total shortfall for first dry season (m3)	Days of shortfall during first dry season
1989 - 1990	19.5%	126 773	14
1995 - 1996	13.6%	149 276	16
1996 - 1997	15.8%	183 733	20
1997 -1998	10.3%	350 167	37
1998 - 1999	17.8%	45 789	5
1999 - 2000	22.3%	0	0
2000 - 2001	23.4%	4 966	1
2001 - 2002	18.8%	0	0
2002 - 2003	22.6%	0	0

2005 - 2006	26.6%	0	0
2006 - 2007	24.1%	18 737	2
2007 - 2008	16.7%	19 549	3
2008 - 2009	18.0%	55 047	6
2009 - 2010	15.4%	167 800	18
2010 - 2011	22.2%	98 198	11
2011 - 2012	18.7%	10 864	11
2012 - 2013	19.3%	97 588	11

With Option 2, the water abstraction rate from the Birbir River was increased from zero until no water deficit was noted in the 17 two-year precipitation scenarios. The results of the modelling indicate that with an additional 30 ℓ/s of constant pumping from the Birbir River to WD1, starting on the day that the Ore Processing Plant is commissioned, none of the 17 two-year precipitation scenarios show a water shortfall. The results of the modelling also indicate that WD2 and the associated diversion infrastructure may need to be constructed in the longer term to maintain control of the TSF supernatant pond volume.

Based on a review of risk (process water shortfalls) and capital costs, Knight Piésold (2020b) recommend abstraction from the Birbir River and the installation of pumping and pipework with a nominal capacity of 55 ℓ/s.

As mentioned previously in Section 2.5.1, the open pits will generate water by means of groundwater inflow and will also receive direct rainfall (catchment runoff is unlikely to reach the pit due to its elevated topography). Water that accumulates in the pit (including groundwater and rainfall) will be pumped into WD1 to supply make-up water to the Ore Processing Plant. This will likely only commence in the third year of the LOM.

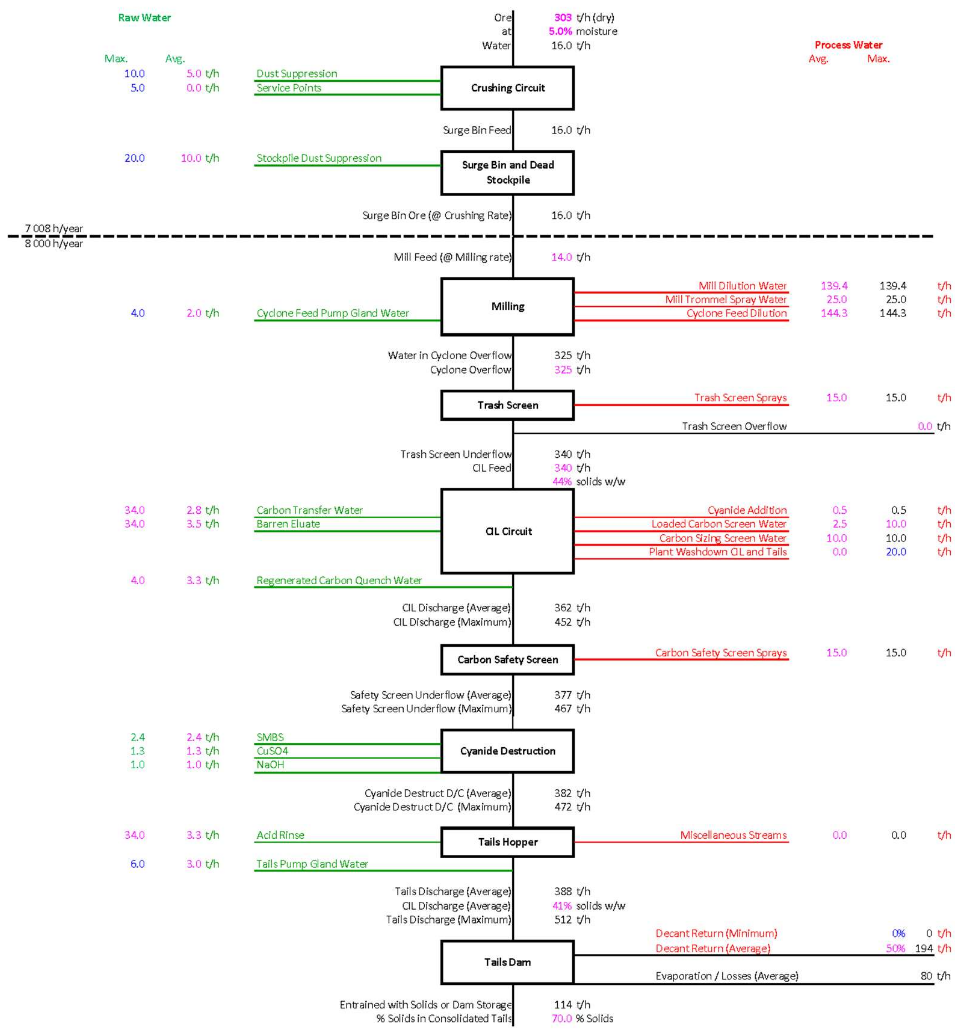
Lycopodium

Project	Tulu Kapi Gold Mine Project
Client	Tulu Kapi Gold Mine S. C.
Date	13-Feb-20
Revision	B _WIP

SIMPLIFIED OVERALL WATER BALANCE - OXIDE ORE

Flowrates	Avg.	Max./Inst.	
Process Water Pumps	352	379	t/h Total into Slurry
Raw Water	37.7	122	t/h Total
Raw Water	22.7	87	t/h Total into Slurry
Potable Water	1.8	3.6	t/h Total

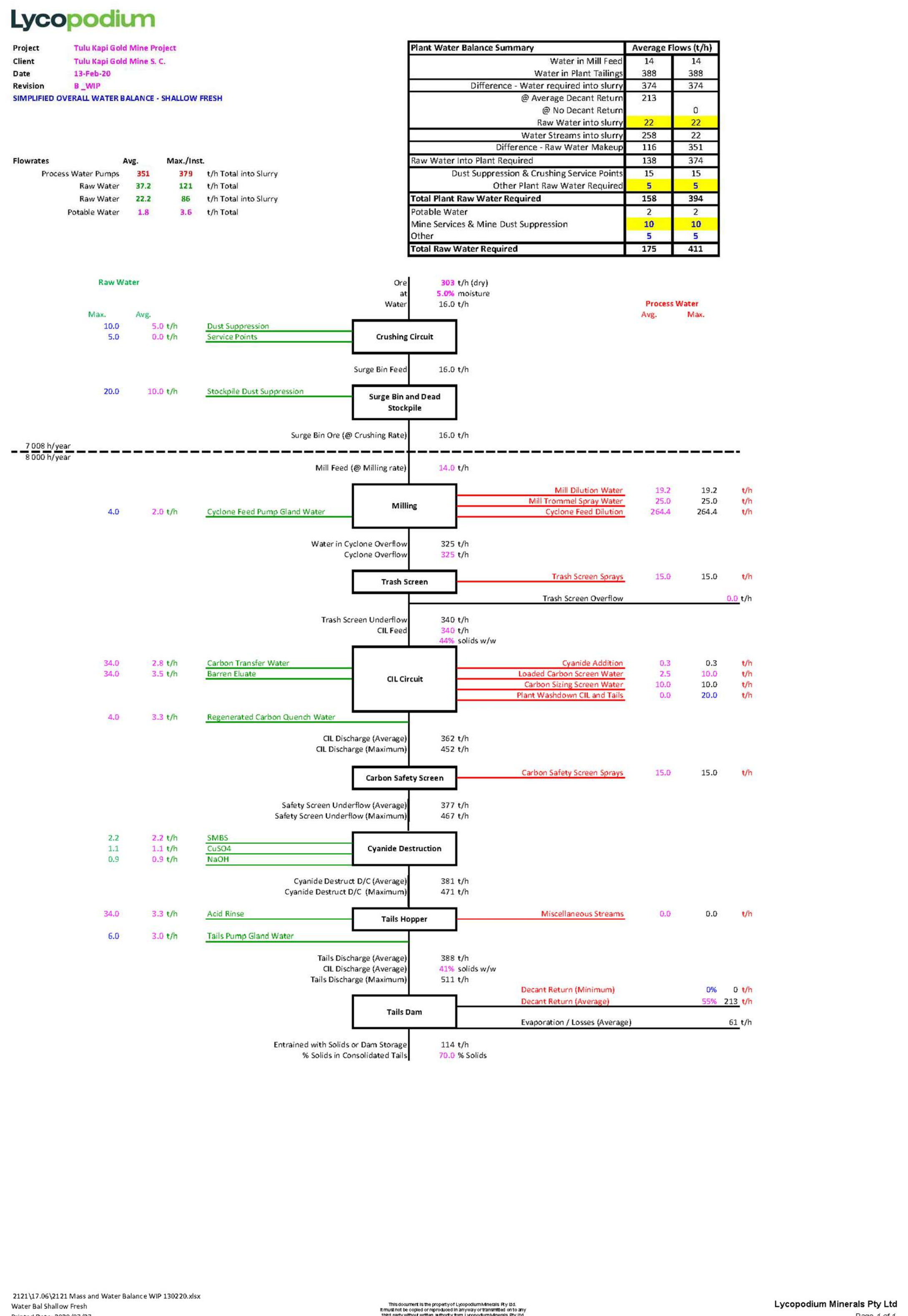
Plant Water Balance Summary	Average Flows (t/h)	
Water in Mill Feed	14	14
Water in Plant Tailings	388	388
Difference - Water required into slurry	374	374
@ Average Decant Return	194	
@ No Decant Return		0
Raw Water into slurry	23	23
Water Streams into slurry	217	23
Difference - Raw Water Makeup	158	352
Raw Water Into Plant Required	180	374
Dust Suppression & Crushing Service Points	15	15
Other Plant Raw Water Required	5	5
Total Plant Raw Water Required	**200**	**394**
Potable Water	2	2
Mine Services & Mine Dust Suppression	10	10
Other	5	5
Total Raw Water Required	**217**	**411**



2121\17.06\2121 Mass and Water Balance WIP 130220.xlsx
Water Bal Oxide
Printed Date: 2020/07/27

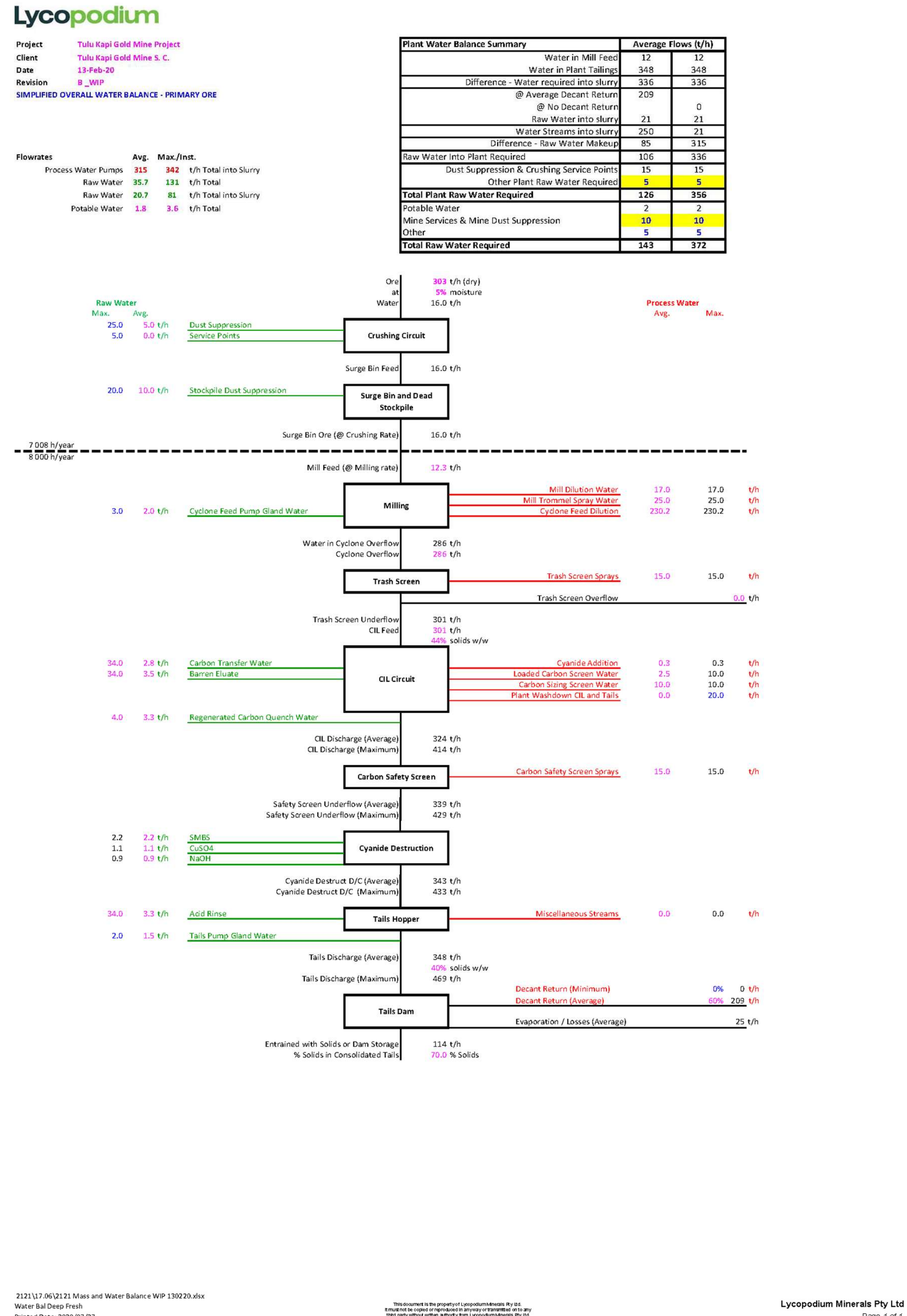
Lycopodium Minerals Pty Ltd
Page 1 of 1

Figure 5-19: Simplified overall water balance – Oxide Ore



Plant Water Balance Summary	Average Flows (t/h)	
Water in Mill Feed	14	14
Water in Plant Tailings	388	388
Difference - Water required into slurry	374	374
@ Average Decant Return	213	
@ No Decant Return		0
Raw Water into slurry	22	22
Water Streams into slurry	258	22
Difference - Raw Water Makeup	116	351
Raw Water Into Plant Required	138	374
Dust Suppression & Crushing Service Points	15	15
Other Plant Raw Water Required	5	5
Total Plant Raw Water Required	**158**	**394**
Potable Water	2	2
Mine Services & Mine Dust Suppression	10	10
Other	5	5
Total Raw Water Required	**175**	**411**

Figure 5-20: Simplified overall water balance – Shallow Fresh



Plant Water Balance Summary	Average Flows (t/h)	
Water in Mill Feed	12	12
Water in Plant Tailings	348	348
Difference - Water required into slurry	336	336
@ Average Decant Return	209	
@ No Decant Return		0
Raw Water into slurry	21	21
Water Streams into slurry	250	21
Difference - Raw Water Makeup	85	315
Raw Water Into Plant Required	106	336
Dust Suppression & Crushing Service Points	15	15
Other Plant Raw Water Required	5	5
Total Plant Raw Water Required	**126**	**356**
Potable Water	2	2
Mine Services & Mine Dust Suppression	10	10
Other	5	5
Total Raw Water Required	**143**	**372**

Figure 5-21: Simplified overall water balance – Deep Fresh

5.10. Soils

The soil survey was conducted within an area of about 11.3 square kilometres inside the land allocated for the project operations. Figure 54 below shows the location of the soil survey area in the Project area. Note that the baseline data collection was conducted beginning in 2008, and that the project description has since been updated. Tests pits were located throughout the MLA to provide an overview of baseline soil conditions in the Project area. While every effort was made to locate test pits in proposed locations of infrastructure, those locations may change in detailed design and the soil survey captures a broad survey to address any modifications to the infrastructure during detailed design.

Soils data results provide information useful for water management, stripping and storage and stability associated with the engineering design and management plans associated with environmental and social impact assessment.

5.10.1. Physiography

The Project area is characterized by a highly dissected and hilly terrain with slopes ranging from very steep to almost flat. It can generally be categorized into the following three physiographic units:

- A sharply crested, highly dissected mountainous and hilly area with slopes ranging from very steep to almost flat and high internal relief
- An undulating to rolling area with slopes ranging from moderately steep to almost flat and a high internal relief
- Valley bottoms which are flat, and a long narrow terrain of fluvial origin. The valley bottoms are located between the dissected terrains of the above physiographic units. The soils of the valley bottoms are Fluvisols developed from alluvial deposits. They are poorly drained, and they restrict rooting because of a raised water table

A general slope of over 15% in 44% of the area has been observed implying the possible occurrence of erosion hazards unless mitigative measures are considered.

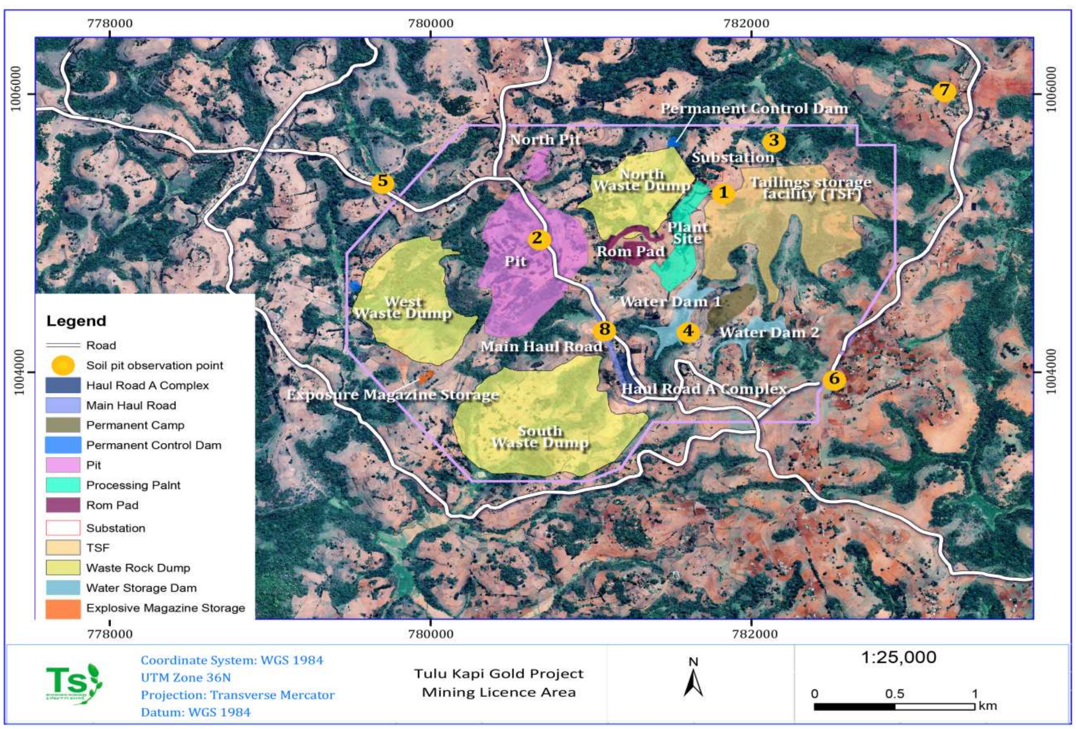


Figure 5-22: Location of the soil pit observation points within the Project area

5.10.2. Cation-Exchange Capacity

The studied morphological and physicochemical characteristics were used in the classification of the soils of the Project area. Accordingly, the presence or absence of specific diagnostic horizons, properties and materials were used to distinguish soils units and subunits as given in the World Reference Base ("WRB") classification system (FAO- WRB, 1998). The studied profiles are shown in Table 5-7 and Figure 5-23shows soils for the Project area.

Table 5-6: Percentage distribution of soil types in the Project area

Soil Type	Area in ha	% of total	Description
Acrisols	300	27	Acrisols are characterised by accumulation of low activity clays in an argic subsurface horizon and by a low base saturation level (WRB, 1998)
Ferralosols	412	37	Ferralsols are deeply weathered, red or yellow soils of the humid tropics. These soils have diffuse horizon boundaries, a clay assemblage dominated by low activity clays and a high content of sesquioxides (WRB, 1998).
Fluvisols	94	8	Exhibit irregular variations with depth in soil texture and colour and shows evidence of stratification and characterized by poor drainage condition and they restrict rooting because of a raised water table mainly during the rainy season during the survey time the water table is at 75 cm, with weak horizon differentiation, but a distinct Ap horizon and AC horizon of several stratification.
Lixisols	307	28	Lixisols exhibit high clay accumulation in a subsurface horizon and high base saturation.
Grand Total	**1 113**	**100**	

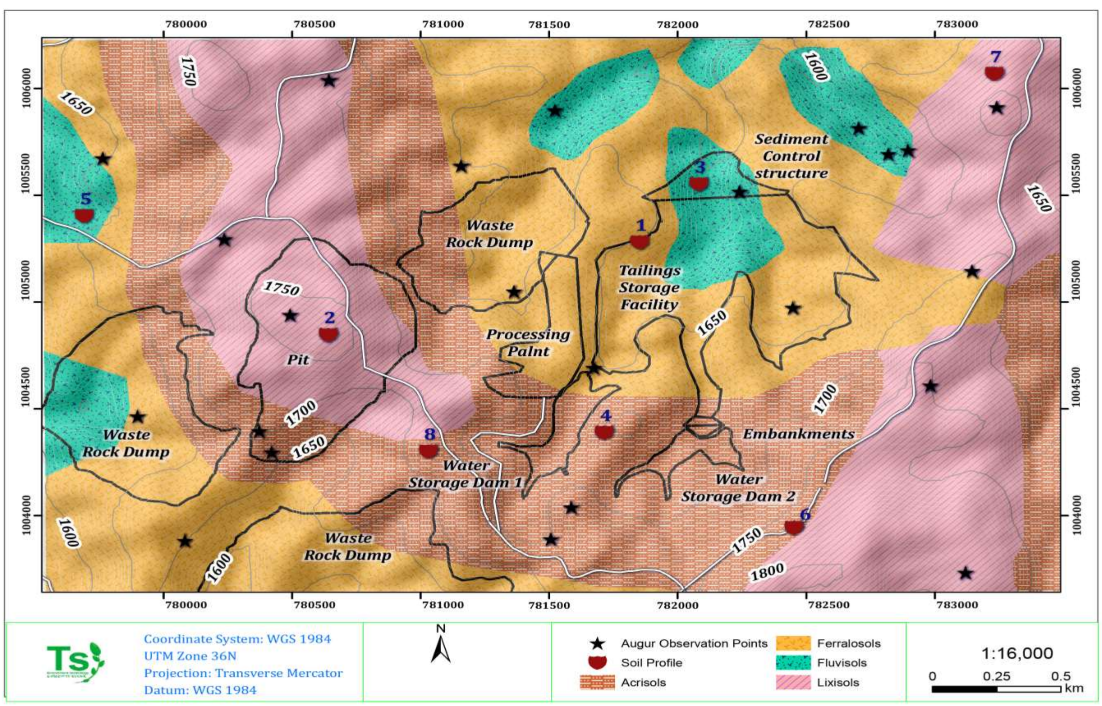


Figure 5-23: Soils map of the Project area (Note: Baseline data collection was conducted in 2012; the project description has since been updated)

5.10.3. Physical Characteristics of the Soils

The textural class of the studied soils varied from sandy clay loam or sandy loam in the surface to sandy clay loam to clayey in the subsoil horizons. The contents of clay varied from 17% in topsoil horizon of profile 2 to 51% in subsoil horizon of the same profile (profile 2). This reveals an increasing pattern of clay and a decreasing pattern in sand and silt contents with depth of most profiles. Hence it is possible to identify most subsoil horizons as argillic (Bt) horizons according to the FAO-WRB (1998) classification legend. In most of the profiles subsoil horizons had uniform clay distributions.

5.10.4. Chemical Characteristics of the Soils

The following chemical characteristics of the soils were evaluated, and the results are detailed in APPENDIX M.

- Soil reaction (pH)
- Electrical conductivity
- Soil organic matter and total nitrogen
- Available phosphorus
- Exchangeable cations, cation exchange capacity and percentage base saturation
- Exchangeable acidity
- Heavy metals and trace elements or trace metals

5.10.5. Land Cover and Land-Use

5.10.5.1. Conceptual Definition

Although the terms land cover and land use are often used interchangeably, their actual meanings are quite distinct. Land cover refers to the surface cover on the ground, while land use refers to the purpose the land serves. The properties measured with remote sensing techniques relate to land cover, from which land use can be inferred, particularly with ancillary data or a prior knowledge (FAO, 1997).

When considering land cover in a very pure and strict sense, it should be confined to description of the vegetation and the man-made features. Consequently, areas where the surface consists of bare rock or bare soil are described as land itself rather than land cover. Also, water surfaces can be disputed as being real land cover.

Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change, or maintain it (FAO, 1997). Land use defined in this way establishes a direct link between land cover and the actions of people in their environment.

5.10.5.2. Land Cover/Land Use in the Project Area

TKGM developed an updated land cover/land use map of the Project area in 2018 (shown in Figure 5-24). The map was based on desktop studies of IKONOS imagery and ground truthing. Nine land cover categories are recognised in these spatial data, with 'cultivated land' and 'forest (coffee + plantation)' the most extensive, followed by 'bush land (grazing)'. The remaining seven categories are defined by small, discrete land parcels that are scattered throughout the Project area. Table 5-8provides a list of land cover categories and their respective hectarages.

Table 5-7: Extent of land cover types in the Project area

Land cover category	Area (ha)
Cultivated land	777.1
Forest (coffee + plantation)	325
Bush land (grazing)	96
Tenant house (2)	9.5
Vegetation	5.7
Degraded land	6.1
Nursery for coffee	-
School	-
Tuku Kapi Camp	1.4

Agricultural activities mostly include the crop production of maize, sorghum, and millet, whilst the forested areas are mostly used to produce coffee. As the assessment was undertaken using aerial imagery, it could not be ascertained which types of crops were produced in the various cropped areas and which forested areas were used for coffee production. However, it can be assumed with a relatively high degree of confidence that the densely forested areas are all used for coffee production. Artificial forested areas are often planted by the coffee farmers to expand their coffee production[6]

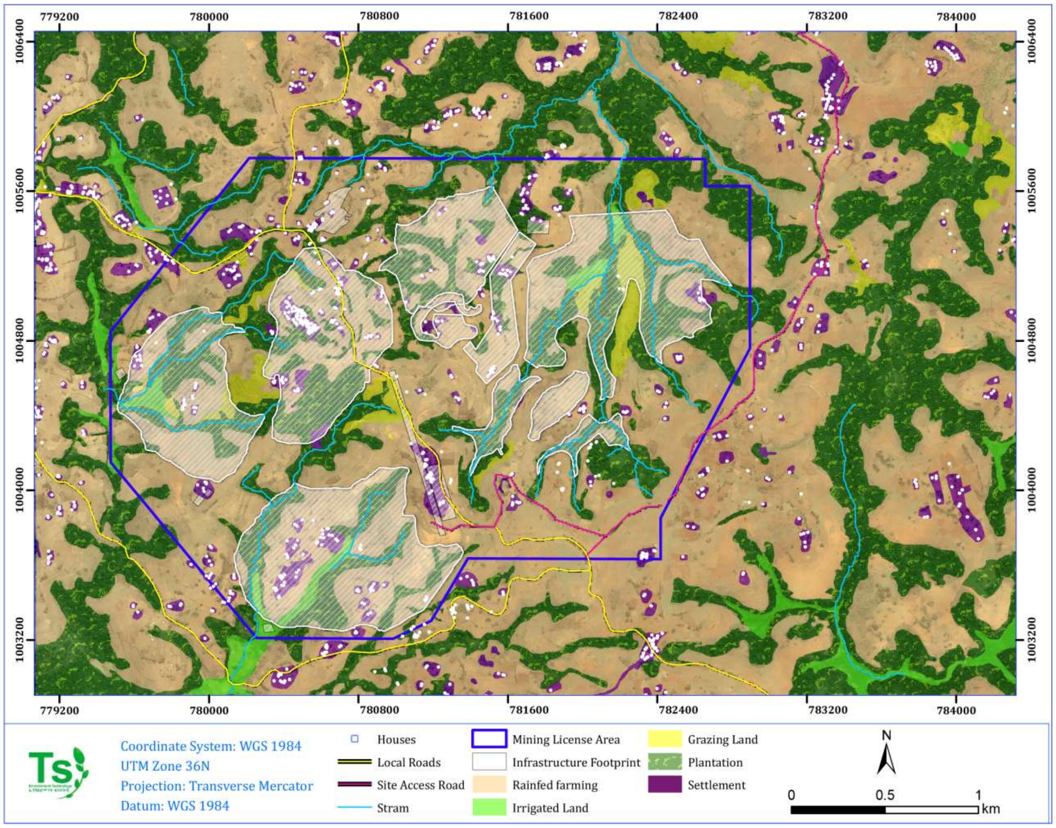


Figure 5-24: Land cover classification of the Project area (2018)

5.10.6. Delineation of Natural and Modified Habitat

In line with IFC Performance Standard 6 (2012), the extent of natural and modified habitats must be established to determine the significance of potential impacts. The IFC Performance Standards recognise that natural and modified habitats exist on a continuum that ranges from largely untouched, pristine natural habitat to intensively managed transformed habitats. To designate an ecosystem as 'modified habitat', it is necessary to determine how human-derived activities have altered ecological structure and function, and indigenous biodiversity. Moreover, it is also important to consider the character of the broader landscape about anthropogenic impacts. Two prominent traits define modified habitats, according to IFC Performance Standard 6 (2012), namely: 1) a large proportion of non-native (alien) flora and fauna, and 2) a substantial alteration of ecological function and species composition driven by human activity.

The classification and delineation of natural and modified habitat for this study was based on an interpretation of the 2018 land cover spatial data (discussed in Section 5.9.2) and field observations made during the 2018 site visit.

Notwithstanding its rural setting, the Project area has a relatively large human population and is defined by a dominant human system overlay (i.e. a strong human-ecological system coupling, *sensu* Scholes 2009). Indeed, all land cover types are extensively used by local communities for various livelihood purposes, and the entire Project area and its surrounds are essentially agricultural landscapes – reflected in Figure 5-25.

Figure 5-25: Typical view across the Project area, showing a mosaic of cultivation, open grassland, woodlots/wind rows, forest patches, and rural homesteads and villages

'Forest' patches throughout the Project area are actively farmed for coffee. Despite their 'natural' appearance, both vegetation structure and composition are noticeably dissimilar to natural forest patches. In accordance with IFC Performance Standard 6 (2012), forested patches in the Project area are thus classified as 'modified 'habitat. Similarly, 'cultivated land', sites of built infrastructure (e.g. 'tenant house'), and those with a disturbed categorisation (e.g. 'degraded land' or 'nursery for coffee') are classified as 'modified' habitats.

The 'Bush land (grazing)' cover class comprises open grassland habitat, which, despite being heavily grazed by domestic livestock, retain the structure and function of natural grassland. Accordingly, these areas are classified as natural habitat, in line with IFC PS6 (2012).

Pursuant to the above rationale, the majority (92%) of the Project area is classified as modified habitat, with the remaining 8% natural habitat. Table 42 provides a breakdown of the hectares and relative percentage proportion of modified and natural habitat, while Figure 58 shows the delineation of modified and natural habitat in the Project area.

Table 5-8: Approximate extent of natural and modified habitat in the Project area

Habitat Classification	Area (ha)	Approximate proportion (%) of LSA
Natural habitat	96	8
Modified habitat	1124.6	92
Total	**1220.6**	**100**

5.10.7. Protected Land

Based on a review of the Environmental Protection Agency (now known as MEFCC) database, the Project area is not located on or in proximity to a protected area or national park. Disturbed categorisation (e.g. 'degraded land' or 'nursery for coffee') are classified as 'modified' habitats.

The ‘Bush land (grazing)’ cover class comprises open grassland habitat, which, despite being heavily grazed by domestic livestock, retain the structure and function of natural grassland. Accordingly, these areas are classified as natural habitat, in line with IFC PS6 (2012).

Pursuant to the above rationale, the majority (92%) of the Project area is classified as modified habitat, with the remaining 8% natural habitat. Table 5-10 provides a breakdown of the hectares and relative percentage proportion of modified and natural habitat, while Figure 5-26shows the delineation of modified and natural habitat in the Project area.

Table 5-9: Approximate extent of natural and modified habitat in the Project area

Habitat Classification	Area (ha)	Approximate proportion (%) of LSA
Natural habitat	96	8
Modified habitat	1124.6	92
Total	**1220.6**	**100**

1.1.2 Protected Land

Based on a review of the Environmental Protection Agency (now known as MEFCC) database, the Project area is not located on or in proximity to a protected area or national park.

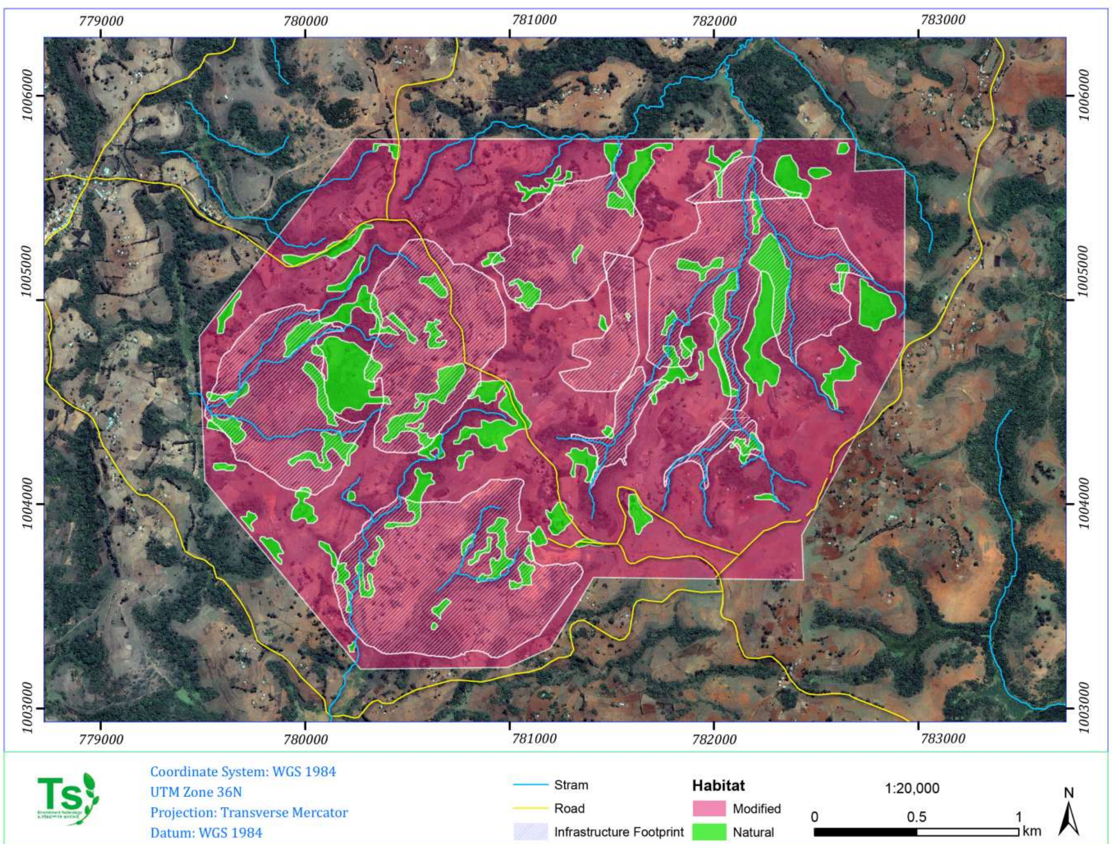


Figure 5-26: Delineation of natural and modified habitat in the Project area, based on land cover imagery

5.11. Terrestrial Ecology

5.11.1. Flora Assessment

Detailed assessment study of the vegetation of the Project area was originally undertaken from 21 to 24 October 2010 to determine possible impacts from the envisaged gold mining activities on the vegetation and existing plant species. A follow-up dry season field screening visit was conducted from 31 August 2018 to 8 September 2018.

5.11.2. Habitat Units

From a vegetation perspective, the Project area comprises three main habitat units; forest patches, grassland and cultivated fields (see Figure 56). None of these are considered undisturbed natural vegetation communities.

5.11.3. Forest Patches

Forest patches in the Project area are mostly confined to valley areas, where they are farmed for coffee. A prevalence of shade trees suggests that they are natural forest patches. However, they are actively managed coffee ‘forest patches’, with the clearing of seedlings and saplings of woody plants and all the herbaceous plants to avoid or reduce competition with coffee plants, causing noticeable degradation. Accordingly, the diversity of both woody and herbaceous species is low.

Although the forest patches in the valleys and adjacent lower parts of hillsides have good tree cover, these areas have experienced severe biodiversity loss. Nevertheless, the disturbed forest patches and the other areas (excluding cultivated fields) have been found to be relatively rich in plant biodiversity harbouring about 246 vascular plant taxa, of which nine are endemic to Ethiopia.

Since coffee has been cultivated for years, the removal of seedlings and saplings of woody species and all herbaceous individuals from the coffee plantation undergrowth, the diversity of woody plant species is very low. For example, woody species like *Polyscias fulva*, *Prunus africana*, *Apodytes dimidiata* and *Schefflera abyssinica* have been reduced to a few scattered individuals.

The upper canopy of forested coffee plantations in valleys and lower parts of the hillsides is mainly dominated by leguminous tree species like *Albizia gummifera*, *Albizia malacophylla* and *Millettia erruginea*. In the upper hillsides, *Acacia abyssinica* becomes the dominant shade tree species. Broad-leaved tree species are not preferred as shade trees, and they are represented by only a few individuals.

Although *Cordia africana* is considered the most valued timber and handicraft timber species, it is also not preferred for shade, but is still more abundant than the afore-mentioned broad-leaved tree species because of its usefulness for handicrafts and timber.Rocky hillsides are generally covered by remnants of woodland species, with *Gardenia ternifolia*, *Stereospermum kunthianum* and *Schrebera alata* commonly recorded. The undergrowth is dominated by shrubs like *Acanthus polystachyus*, *Echinops amplexicaulis*, *Echinops giganteus* and *Crotalaria mildbraedii*. These degraded areas and the abandoned crop fields in the valleys, hillsides and top of hills are used for grazing.

Figure 5:27 Forested areas are common in valley bottoms in the Project area.

Figure 5-28: Coffee plants (*Coffea arabica*) (dark green in under storey) are actively cultivated beneath an upper canopy of taller indigenous trees.

5.11.4. Cultivated Fields

The non-coffee growing areas, both in the valleys and hilly areas have been put under crop cultivation. The valleys are mainly planted with maize (Figure 5-29), while the hillsides and tops are placed mainly under wheat of pastures grasses such as *Eragrostis tef* or *Digitaria* sp. (Figure 5-30). Other minor crops, such as broad bean and peas are also planted in relatively dry areas in valleys, and on sides and tops of hills.

In addition to food crops like *Dioscorea alata*, *Dioscorea bulbifera*, *Musa x paradisiaca*, *Mangifera indica*, *Phaseolus lunatus*, *Phaseolus vulgaris*, *Nicotiana tabacum* etc. *Coffea arabica* is cultivated in most homesteads, while *Eucalyptus camaldulensis, Senna* spp., *Spathodea campanulata*, is also widely grown in and around the homesteads, and along walkways and on the borders of crop fields.

Figure 5-29: valleys are mainly planted with maize

Figure -30: hillsides and tops are placed mainly under wheat of pastures grasses such as *Eragrostis tef* or *Digitari*

5.11.5. Grassland

Open grasslands occur in throughout the Project area, wherever cultivated fields and forest patches are absent. In land cover imagery, these areas are classified as Bushland. They are used extensively for livestock grazing and as a result, they are characteristically very short, and often form grazing lawns (Figure5-31).

In terms of composition, grasslands comprise a mixture of species including *Cynodon dactylon, Eleusine sp., Eragrostis sp., Hyparrhenia sp., and Sporobolus africana/pyramidalis*. Scattered trees, woodlots/windrows are also present, and mostly comprise alien taxa, such as *Eucalyptus grandis, E. camaldulensis,* although indigenous *Albizia* and *Acacia* species were also noted.

Figure 5-31: Grasslands cover large areas and are used extensively for livestock grazing.

5.11.6. Recorded Floral Species

A detailed assessment of land use and land resources showed the existence of about 244 plant species in the Project area, of which 45 are cultivated, 30 taxa have medicinal value, and ten are endemic taxa. Recognised group are discussed below:

5.11.7. Wild Plants

Most of the woody plants were recorded in the managed coffee plantations. The most common shade trees include the leguminous plants, which are known for their nitrogen fixing characteristic and are therefore are commonly used as coffee shade trees (e.g. see Thulin, 1989). These include *Albizia gummifera*, *Albizia malacophylla*, *Millettia ferruginea* and *Acacia abyssinica*. Other non-nitrogen-fixing broad-leaved trees include *Apodytes dimidiata*, *Cordia africana* and *Trichilia dregeana*. *Cordia africana* has been reported as the most important tree in terms of ecosystem services provision and is used as a timber source and for handicrafts.

5.11.8. Cultivated Plants

A total of 45 vascular plant species have been recorded occurring in cultivation. Most of them are crop plants cultivated for house-hold consumption, including *Catha edulis*, *Coffea arabica* and *Nicotiana tabacum* (stimulants) and *Rhamnus prinoides* (a plant used to add favour to a locally brewed drink, 'tela').

5.11.9. Crop Plants

Of the 45 species of cultivated plants that have been encountered in the Project area, 33 were edible plants (plants grown for consumption, including stimulants and "hop"), while 12 species have been planted for other uses. The edible plants include:

- **Cereals**: *Eragrostis tef*, *Eleusine coracana*, *Sorghum bicolor*, *Triticum aestivum*, and *Zea mays*
- **Fruit crops**: *Carica papaya*, *Mangifera indica*, *Musa x paradisiaca* and *Psidium guajava*
- **Oil crops**: *Brassica carinata* and *Guizotia abyssinica*
- **Root and bulbous crops:** *Coccinia abyssinica*, *Colocasia esculenta*, *Dioscorea abyssinica*, *Dioscorea bulbifera*, *Ipomoea batatas*, *Manihot esculenta*, *Plectranthus edulis* and *Xanthosoma sagittifolium*
- **Pulses: Phaseolus lunatus, P. vulgaris, Pisum sativum and Vicia faba**
- **Stimulants: Catha edulis, Coffea arabica and Nicotiana tabacum**
- **Vegetables**: *Brassica carinata*, *B. oleracea* and *Capsicum annuum*

5.11.10. Medicinal Plants

About 34 species growing in the Project area have been reported to have medicinal value. These include: *Acanthus polystachyus*, *Achyranthes aspera*, *Albizia gummifera*, *Allium cepa*, *Allium sativum*, *Bersama abyssinica*, *Brassica carinata*, *Bridelia micrantha*, *Calpurnia aurea*, *Carica papaya*, *Catha edulis*, *Clausena anisata*, *Clematis longicauda*, *Clematis simensis*, *Coccinia abyssinica*, *Croton macrostachyus*, *Echinops amplexicaulis*, *Echinops giganteus*, *Eucalyptus camaldulensis*, *Eucalyptus grandis*, *Gardenia ternifolia*, *Girardinia diversifolia*, *Guizotia abyssinica*, *Hygrophila schulli*, *Justicia schimperiana*, *Melia azedarach*, *Millettia ferruginea*, *Nicotiana tabacum*, *Ocimum lamiifolium*, *Rhamnus prinoides*, *Schefflera abyssinica*, *Solanum giganteum*, *Trichilia dregeana* and *Vernonia amygdalina*.

5.11.11. Timber Species

Twelve tree species planted in the Project area (mainly in homesteads) have been reported to being used for construction, fuelwood, ornamentation and other purposes. These include *Cupressus lusitanica*, *Eucalyptus camaldulensis*, *Eucalyptus grandis*, *Euphorbia ampliphylla*, *Euphorbia cotinifolia*, *Euphorbia pulcherrima*, *Justicia schimperiana*, *Lagenaria siceraria*, *Melia azedarach*, *Phoenix reclinata*, *Sesbania sesban* and *Spathodea campanulata*.

1.1.2.1 Endemic and Threatened Floral Species

Among the total 244 species of vascular plants (both wild and cultivated), there are ten species and subspecies that are endemic to the floristic region (Ethiopia and Eritrea). Nine of these are strictly endemic to Ethiopia; *Bidens ghedoensis*, *Brillantaisia grotanellii*, *Clematis longicauda*, *Coccinia abyssinica*, *Eragrostis tef*, *Justicia diclipteroides* subsp. *aethiopica*, *Lippia adoensis*, *Millettia ferruginea*, *Trifolium mattirolianum* and *Vernonia leopoldii*.

Only *Brillantaisia grotanellii* has been assessed as fulfilling the threatened category Vulnerable (VU) by Vivero *et al.* (2006). Despite the findings of Vivero *et al.* (2006), *Brillantaisia grotanellii* may be re-assessed as fulfilling only the Near Threatened category in the final conservation assessment, since this species is known to occur in five floristic regions of Ethiopia (i.e. Gonder, Gojam, Ilubabor, Kefa and Welega). After all, there is no natural vegetation in the Project area where the species may be protected by setting aside a protected area; all the riverine forest patches have been used for coffee plantation that has resulted in the removal of seedling and saplings of woody plants.

1.1.2.2 Invasive Alien Species

Several invasive alien plants were recorded in the project area including *Ageratum conyzoides, Caesalpinia decapetala*, *Eichornia crassipes*, *Lantana camara*, *Opuntia ficus-indica*, *Parthenium hysterophorus* and *Prosopis juliflora*, and *Ricinus communis*.

5.11.12. Fauna Assessment

The fauna study included a survey of the wild animals present in and adjacent to the Project area, with emphasis on birds, mammals, and fish.

5.11.13. Birds

The Project area is relatively small and similar in habitat structure, predominantly covered by agricultural land, and some disturbed forest patches along streams that are used for coffee production. The disturbed coffee- forest patches are considered a modified habitat – see Section 5.9.3.

GBIF (2018) records for the region suggest that 193 bird species potentially occur in the Project area. Sixty-four taxa recorded during the 2015 field survey and 71 taxa during 2018. Of recorded species, four are listed by the IUCN as being globally threatened - Table 5-11. These include two critically endangered taxa; the White-backed Vulture (*Gyps africanus*) and Hooded Vulture (*Necrosyrtes monachus*) (Figure 64). An additional three species of conservation concern that have been recorded in the broader region (GBIF records) may also be present in the Project area – also listed in Table 5-11.

Among the biome assemblage species, 10 Afrotropical Highland Biome (HB) species were recorded from the area. There are 48 HB species in Ethiopia, and the site holds only 20% of that. The list of endemic species and HB species is presented in Table 5-12

Table 5-10: Globally threatened bird species (Red List) recorded and potentially occurring in the Project area.

Family	Scientific Name	Common Name	Red List Status (IUCN 2018-2)	Recorded in Project area
Accipitridae	*Gyps africanus*	White-backed Vulture	Critically Endangered	□
	Necrosyrtes monachus	Hooded Vulture	Critically Endangered	□
	Aquila rapax	Tawny Eagle	Vulnerable	
	Terathopius ecaudatus	Bateleur	Near Threatened	
Bucerotidae	*Bucorvus abyssinicus*	Abyssinian Ground Hornbill	Vulnerable	□
Ciconiidae	*Ciconia episcopus*	Woolly-necked Stork	Vulnerable	□
Gruidae	*Balearica pavonina*	Black-crowned Crane	Vulnerable	
Source: GBIF (2018)				

Table 5-11: List of endemic and biome-specialist bird species recorded in the Project area

Family	Scientific Name	Common Name	Endemic Status	IBA Category
Columbidae	*Streptopelia lugens*	Dusky Turtle Dove	-	HB
Corvidae	*Corvus crassirostris*	Thick-billed Raven	Endemic	
Fringillidae	*Serinus citrinelloides:*	African Citril	-	HB
	Serinus striolatus	Streaky Seed-eater	-	HB
	Serinus tristriatus	Brown-rumped Seed-eater	-	HB
Lybiidae	*Lybius undatus*	Banded Barbet	Endemic	
Musophagidae	*Tauraco leucotis*	White cheeked Turaco	-	HB
Oriolidae	*Oriolus monacha*	Abyssinian Black headed Oriole	-	HB
Psittacidae	*Agapornis taranta*	Black-winged Love Bird	Endemic	HB
	Poicephalus flavifrons	Yellow-fronted Parrot	Endemic	HB
Timaliidae	*Pseudoalcippe abyssinica*	African Hill Babbler	-	HB
Turdidae	*Myrmecocichla semirufa*	White-winged Cliff Chat	Endemic	HB
HB = Afrotropical Highland Biome Assemblage species				

Figure 5-32: Hooded Vulture (*Necrosyrtes monachus*) – Critically Endangered

Figure 5-33: Abyssinian Hornbill (*Bucorvus abyssinicus*) – Vulnerable

Figure 5-34: Abdim's Stork (*Ciconia abdimii*)

5.11.14. Mammals

Since it is predominantly agricultural land and settlement, the Project area has a very poor indigenous mammal diversity. Only a few cosmopolitan species, such as Colobus Monkey (*Colobus guereza*) and Grivet Monkey (*Chlorocebus aethiops*), were seen and/or indicated to occur in the area by the local informants. Interestingly, despite the evident human pressures, Spotted Hyaena (*Crocuta crocuta*) was confirmed to occur in the Project area, during the 2018 field visit. The species is a large apex predator that because of conflict with humans, is locally extirpated throughout much of its historic range.

In total, nine mammal species have been recorded in the Project area to-date. Seven were recorded during the 2015 field survey, while five species were recorded during the 2018 (Table 5-13). Figure 5-35 to Figure 5-36 show images of mammals photographed during opportunistic encounters or on camera traps in the Project area, during the 2018 field survey.

None of the mammal species recorded in the Project area are of conservation concern. We note that various streams from the Project area flow into the Birbir River, which, although outside the Project area, has a population of Hippopotamus (*Hippopotamus amphibius*) – a Vulnerable species (IUCN 2018-2). The GBIF dataset also indicates that the African Straw-coloured Fruit-bat (*Eidolon helvum*), which is listed as Near Threatened (IUCN 2018-2), has been recorded in the broader region in which the Project area is located.

Table 5-12: **List of mammals recorded in the Project area and their conservation status**

Family	Scientific Name	Common Name	Red List Status (IUCN 2018-2)	Field Records	
				2015	2018
Canidae	*Canis mesomelas*	Black-backed Jackal	LC	□	□
Cercopithecidae	*Colobus guereza*	Colobus Monkey	LC	□	□
	Chlorocebus aethiops	Grivet (Vervet) Monkey	LC	□	□
	Papio anubis	Olive Baboon	LC	□	
Herpestidae	*Ichneumia albicauda*	White-tailed Mongoose	LC		□
Hyaenidae	*Crocuta*	Spotted Hyena	LC	□	□
Hystricidae	*Hystrix cristata*	Crested Porcupine	LC	□	
Orycteropodidae	*Orycteropus afer*	Aardvark	LC	□	
Sciuridae	*Heliosciurus* sp.	Squirrel sp.	LC		□


Figure 5-35: Black-backed Jackal (*Canis mesomelas*)


Figure 5-36:White-tailed Mongoose (*Ichneumia albicauda*)

Figure 5-37:Colobus Monkey (*Colobus guereza*, *aethiops)*

Figure 5-38: Grivet Monkey (*Chlorocebus aethiops*)

5.11.15. Herpetofauna (Reptiles and Amphibians)

Reptile and amphibian surveys were not conducted as part of the 2010 field programme. In this section, we present lists of reptile and amphibian species (Table5-14 and Table 5-15, respectively) that have been observed in the broader region in which the Project area is located, based on the GBIF (2018) records. The Red List status according to the IUCN (2018) of recorded taxa is also provided.

Table 5-14: Reptiles recorded in the broader region.

Family	Scientific Name	Common Name	Red List Status (IUCN 2018-2)
Viperidae	*Bitis arietans*	Puff Adder	-
Agamidae	*Agama doriae*	Benoue Agama	-
Scincidae	*Trachylepis quinquetaeniata*	African Five-lined Skink	-
Colubridae	*Philothamnus bequaerti*	Bequaert's Green Snake	-

Family	Scientific Name	Common Name	Red List Status (IUCN 2018-2)
Colubridae	*Dasypeltis scabra*	Rhombic Egg Eater	LC
Colubridae	*Crotaphopeltis hotamboeia*	Red-lipped Snake	-
Lamprophiidae	*Pseudoboodon boehmei*	Sandford's Ethiopian Snake	-
Lamprophiidae	*Atractaspis irregularis*	Variable Burrowing Asp	LC
Chamaeleonidae	*Chamaeleo gracilis*	Slender Chameleon	LC
Lamprophiidae	*Prosymna greigerti*	Southern Sahel Speckled Shovel-snout	-
Lamprophiidae	*Psammophis sibilans*	Western Yellow-bellied Sand Snake	LC
Chamaeleonidae	*Chamaeleo senegalensis*	Senegal Chameleon	LC
Lamprophiidae	*Lamprophis erlangeri*	Aurora House Snake	-
Scincidae	*Chalcides bottegi*	Ocellated Skink	-
Scincidae	*Trachylepis wingati*	Wingate's Skink	-
Source: GBIF (2018)			

Table 5-15 Amphibians recorded in the broader region (GBIF).

Family	Scientific Name	Common Name	Red List Status (IUCN 2018-2)
Bufonidae	*Amietophrynus regularis*	African Toad	LC
Phrynobatrachidae	*Phrynobatrachus natalensis*	Natal Dwarf Puffle Frog	LC
Hyperoliidae	*Hyperolius nasutus*	Long Reed Frog	LC
Ptychadenidae	*Ptychadena taenioscelis*	Dwarf Grass Frog	LC
Ptychadenidae	*Ptychadena erlangeri*	Erlanger's Grassland Frog	NT
Bufonidae	*Amietophrynus maculatus*	Hallowell's Toad	LC
Hyperoliidae	*Hyperolius viridiflavus*	Common Reed Frog	LC

Family	Scientific Name	Common Name	Red List Status (IUCN 2018-2)
Arthroleptidae	*Leptopelis gramineus*	Badditu Forest Treefrog	LC
Ptychadenidae	*Ptychadena anchietae*	Plain Grass Frog	LC
Source: GBIF (2018)			

5.12. Aquatic Ecology

5.12.1. Study Area

The Project area is drained by several small streams, which eventually join the Birbir River, which in turn is the major tributary of the Baro River. The Baro River is a major tributary of the White Nile Drainage (Baro-Akobo basin). Prior to studies conducted by the Joint Ethio-Russian Biological Expedition (JERBE), only eight (8) fish species were reported from the White Nile Drainage in Ethiopia (Tedla, 1973 from Golubtsov and Darkov, 2017 and Tadlo, 2015). A substantial amount of new data was accumulated through the JERBE expeditions with 113 fish species belonging to 26 families and 60 genera being recorded (Golubtsov and Darkov, 2017). The results of the 20 years of data collection across the drainage basin have seen the White Nile Drainage within the limits of Ethiopia far exceed the other regions in terms of fish diversity (Golubtsov and Darkov, 2017). A report by Tadlo, (2015) indicated that the Baro Drainage Basin has a total of 87 fish species with one being endemic.

The streams on site are generally small first order streams with high gradients. Being of such a nature, flow is limited until a few streams join further downstream towards the Birbir River. The Birbir River itself is a deep incised channel approximately 8 meters wide (within the project area). Based on the habitat and the size of the rivers, being generally smaller within the headwaters, it is unlikely that all 87 species would occur at the specific sampling locations selected for this project. It is also highly likely that species not previously sampled will occur in the area, based on the lack of information.

5.12.2. Field Observations

Fish samples were collected by means of electrofishing and netting. Electrofishing is the use of electricity to catch fish. The electricity is generated by a system whereby a high voltage potential is applied between two electrodes placed in the water (USGS, 2004). The responses of fish to electricity are determined largely by the type of electrical current and its wave form. These responses include avoidance, electrotaxis (forced swimming), electrotetanus (muscle contraction), electronarcosis (muscle relaxation or stunning) and death (USGS, 2004). Electrofishing was conducted with a Smith-Root LR-24 portable electrofishing device (DC 12V pulsating). Electrofishing is regarded as the most effective single method for sampling fish communities in wadeable streams (Plafkin *et al.*, 1989). The time spent electrofishing was influenced by the different flow classes and cover elements at the various sites. Thus, more homogeneous sites were sampled for less time than heterogeneous habitats and were also where applicable alternative netting methods were applied.

During electrofishing variables such as conductivity (Hill and Willis, 1994; Pusey *et al.*, 1998), stream width (Kennedy and Strange, 1981), fish size (Zalewski, 1985), temperature (Regis *et al.*, 1981), and operator experience (Hardin and Connor, 1992) have been shown to affect the capture efficiency in fish. The conductivity of the water affects the efficiency of sampling in two ways. Firstly under low conductivity (>100 µs/cm), the effective area of the electrical field is limited by the increased resistance of the water and the corresponding decrease in electrical current (Nelson and Little, 1987). As a result, the electrical field is confined to the area immediately surrounding the electrode. Secondly water with a high conductivity has less resistance than that of the fish, and as a result the current tends to 'flow' around or have little to no effect on the fish (Reynolds, 1983). The Smith-Root LR24 is rated for a conductivity range of 10 – 1500 µs/cm (www.smith-root.com).

Figure 5-39

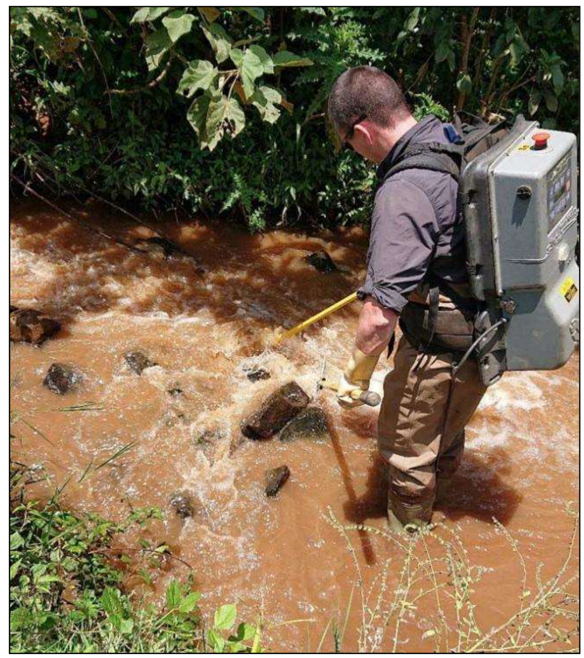


Figure 5-40

Fish were identified in the field, photographed, and released at the point of capture. Fish species were identified using information gathered from Golubtsov and Darkov, (2017); Habteselassie *et al.*, (2010); Stiassny and Getahun, (2007) and Tadlo, (2015) and in consultation with the American Museum of Natural History ("AMNH"). Voucher specimens were preserved in the field (paraformaldehyde solution) and transported back to South Africa for species level identification and cataloguing. Field identifications have been updated based on the AMNH review.

Based on the August 2018 survey, three fish species were recorded on site (Table 5-16). Due to the depth and turbidity of the Birbir River, electrofishing could not be conducted safely. The most abundant fish species was an undescribed sawfin barb. Literature suggests that this species if from the *Enteromius paludinosus* species complex. As very little work has been done within the project area, it will take time to categorise and rename species that have not yet been taxonomically classified, but this study provides the opportunity for this to be done. The Latin abbreviation "*cf.*" (*Confere*) is used when an identification is not confirmed, and the species is similar to but not identical to another. In this situation, the abbreviation in placed between the genus and species name. Therefore, this barbus will be referred to as *Enteromius cf. paludinosus* (Table5- 16 and Figure5- 41).

The second most abundant fish species recorded was the Dembea Stone Lapper (*Garra dembeensis*) (Table 5-16 and Figure 5-42). This species is widely distributed in Africa. It is known from Nigeria to Ethiopia, and from Egypt to Tanzania (IUCN, 2018). *Garra dembeensis* is widely distributed in Ethiopia, occurring in Lake

Tana, Omo, Baro, Abbay, Awash basins (IUCN, 2018; Stiassny and Getahun, 2007), Abaya basin, Lake Shala and Lake Ziway (Stiassny and Getahun, 2007).

One individual of the yellowfish, *Labeobarbus bynni* was recorded at site TKSW11 (Table 5-16 and Figure 5-43).

Table 5-16: Observed fish species - August 2018

Species		**TKSW05**	**TKSW06**	**TKSW11**	**Abundance**
Enteromius cf. paludinosus	Sawfin Barb		12	69	**81**
Garra dembeensis	Dembea Stone Lapper	9	7	5	**21**
Labeobarbus bynni	Yellowfish			1	**1**
Diversity		**1**	**2**	**3**	

Figure 5-41: *Garra dembeensis*

Figure 5-42 *Enteromius cf. paludinosus*

Figure 5-43: *Labeobarbus bynni*

Aquatic Macroinvertebrates were also collected using the standard methodology described in Kaaya *et al.*, (2015). The monitoring of benthic macroinvertebrates forms an integral part of the monitoring of the health of an aquatic ecosystem. Aquatic macroinvertebrates are used as they are relatively sedentary and enable the detection of localized disturbances, are relatively long lived (±1 year) allowing for the integration of pollution effects over time, and field sampling is relatively easy and since the communities are heterogeneous and several phyla are usually represented, response to environmental impacts is normally detectable in terms of the community as a whole (Hellawell, 1977). In order to standardize the sampling effort the sampling protocol of the Tanzanian River Scorning System was used (Kaaya *et al.*, 2015). The TARISS was developed from the South African Scoring System yet would be more applicable in Ethiopia as it takes into consideration more tropical river systems.

The TARISS method relies on churning up the substrate with your feet and sweeping a finely meshed kick net (pore size of 1000 micron), mounted on a 300 mm square frame, over the churned-up area. In the Stones-In-Current habitat (rapids, riffles, runs, etc.) the net is rested on the substrate and the area immediately upstream of the net disturbed by kicking the stones over and against each other to dislodge benthic invertebrates. The net is also swept under the edge of marginal and aquatic vegetation for 1 - 2 m. Kick samples are collected from areas with gravel, sand, and mud substrates. Identification of the organisms is made to family level (Davies and Day, 1998; Dickens and Graham, 2002; Gerber and Gabriel, 2002; Kaaya *et al.*, 2015; Thirion *et al.*, 1995).

Based on the assessment of aquatic macroinvertebrates communities during the August 2018 survey, 24 taxon were recorded, ranging from 7 to 15 per site (Table 5-29). The total TARISS scores ranged from 40 at site TKSW11 to 116 at TKSW06.

The Average Score per Taxa ("ASPT") scores which provide an indication of the average tolerance/ intolerance of the aquatic macroinvertebrate community to impacts on river health, ranged from 4.0 at site TKSW11 to 7.7 at site TKSW06 (Table 49). Based on these findings, it was concluded that the macroinvertebrate communities were composed primarily of moderately tolerant (6 - 10) at sites TKSW05 and TKSW06, whilst site TKSW11 was composed primarily of tolerant (1 - 5) taxa.

The Ephemeroptera, Plecoptera, and Trichoptera ("EPT") taxa are considered to be sensitive to pollution (Barbour *et al.*, 1999), and are commonly associated with undisturbed habitat, and have a preference for flowing well oxygenated waters. Therefore, streams with diverse stones-in-current habitat and mixed flows, the diversity of EPT taxa is expected to be naturally higher. These results follow those of the ASPT scores with sites TKSW05 and TKSW06 scoring higher than site TKSW11.

Table 5-17: Summary of aquatic macroinvertebrate data - August 2018

	TKSW05	TKSW06	TKSW11
Number of Taxa	7	15	10
TARISS Score	49	116	40
ASPT	7,0	7,7	4,0
%EPT	67%	50%	30%

Whilst conducting the TARISS monitoring, visual observations considered adult dragonfly and damselfly species that were present at the site (Figure 5-44). Although different species were observed, the families recorded were already incorporated into the TARISS data sheets. Odonata are synonymous with water, whereby the egg and larval phases are entirely dependent on water (Tarboton and Tarboton, 2002).

Figure 5-44: Various Odonata (Dragonflies and Damselflies) observed on site

Therefore, it is important to note the adults that may be encountered on site, as the larvae may not have been sampled.

To aid interpretation of the biological data, *in situ* water quality and habitat availability was assessed. A summary of the *in-situ* water quality can be viewed in Section 5.7. Based on the measurements obtained, pH, EC, total dissolved solids TDS, dissolved oxygen DO, and saturation (%DO), and water temperature were within guideline values and were not considered limiting to aquatic biota (Table 5-18).

Table 5-18: *In Situ* water quality of biological monitoring sites - August 2018

	pH	EC (mS/cm)	TDS (mg/L)	DO (mg/L)	%DO	Temperature (ºC)
TWQR	6,5-9,0	1,54	<1000	>5,00	80-120	5-30
TKSW05	7,43	0,02	13,0	7,08	82,1	21,8
TKSW06	7,73	0,08	52,0	7,67	81,3	20,3
TKSW11	7,42	0,07	45,5	7,61	85,7	21,5

The Integrated Habitat Assessment System ("IHAS") was developed by McMillan (1998) for use in conjunction with the collection of aquatic macro invertebrates. The August 2018 IHAS results are provided in Table 5-19. The IHAS index considers sampling habitat and stream characteristics. Table 5-19shows the scores calculated in obtaining the final IHAS score as well as a bar graph of the normalised percent contribution per biotope. This allows us to breakdown the IHAS score into what biotopes were the most and least prominent, as well as looking between sites at what contribution the biotopes added to the final score.

Habitat availability for aquatic macro invertebrates ranged from *poor* to *adequate*, with the stones-in-current biotope being the driving factor behind the differentiation.

Table 5-19: The Integrated Habitat Assessment System (IHAS) scores – August 2018

Site	Sampling Habitat				IHAS	
	Stones-in-Current	Vegetation	Other Habitat / General	Physical Stream Condition	Score	Description
TKSW05	7	1	6	23	**37**	**Poor**
TKSW06	13	10	8	27	**58**	**Adequate**
TKSW11	5	11	8	27	**51**	**Poor**

The Birbir River (site TKSW08) was a deep turbid channel with moderately fast flowing water. The Birbir River flows in a westerly direction to the north of the project area. The margins of the Birbir River are heavily vegetated, whilst the substrate that was accessible on the edges was confined to salt deposition.

Site TKSW06 is a tributary of the Birbir River from the northern drainage. The site was located where the road down to site TKSW08 crosses the tributary and as a result there was a small area of inundation upstream leading into a wetland system. This area was predominantly mud and sand and showed signs of cattle disturbance. Downstream of the bridge was an area of faster flowing water with stones and cobbles present. As with the Birbir River, this site showed a high degree of turbidity.

Site TKSW05 is also a tributary of the Birbir River from the northern drainage. The tributary is confined to the forest canopy, with only a small crossing point cleared, which allowed for access and sampling.

Substrate was limited to small stones and gravel as well as mud, with dead branches, roots and leaf litter being the only other habitat available for sampling. Although turbid, this site did not have the same degree of 'orange' turbidity resent.

Figure 5-45:

Figure 5-46:

Site TKSW11 is located in the southern drainage of the project area and flows in a south-westerly direction. The site was comprised primarily of mud, with a gravel bank exposed way small tributary entered from the right bank. The average water depth was 40 to 60 cm, and the banks were undercut and well vegetated.

Most of the other sites visited were first order forest streams and seeps that were not appropriate for electrofishing or biological sampling.

Figure 5-47:

5.12.3. Summary

The river systems associated with the Project are generally first and second order forest streams that flow down into the larger Birbir River and ultimately the Baro River Drainage. Although these streams did not show a high diversity of aquatic biota, in particularly fish during the August 2018 survey, it is believed that these rivers are important water source areas for the downstream rivers and thus remain important to the aquatic biodiversity within the larger catchment. It is recommended that a dry season survey be conducted of the Birbir River when it is more accessible, as it is a larger river, it is likely to host a wider range of species.

5.13. Noise

5.13.1. Noise Level

The baseline noise levels of the Project area were measured to determine existing levels of noises at different sites and surrounding environs (detailed in APPENDIX N). Noise receptors and existing sources of noises were also identified based on representative noise measurement points and are shown in Figure 5-48 (Note that the baseline data collection was conducted beginning in 2008, and the project description has since been updated).

The noise measurements were taken from October 21 to 23, 2010 from selected areas of the Project. The distance between points where measurements were taken varies from about 100 meters (the minimum) to 3 km. Typological features of surveyed sites were documented using GPS. Noise levels were measured at each site using EXTECHTM 407730 Digital Sound Level Meter, with a range from 40 – 130 db, with frequency weighting networks designed to meet the IEC 651 type 2. The Sound Level Meter was calibrated before each according to the procedure outlined on the user’s guide. Noise data was taken at an interval of 30 minutes.

The design of the noise level measurement incorporated the extent of the Project area and the different components of the Project. Measurements for these areas were made from 08h00 to 18h00. As the area is rural farmland, night-time noise measurements are expected to be lower than daytime noise due to human influences, therefore, measurements were confined to daytime measurements. The Project area was divided into three components with proximity to one and other:

- **Study area 1:** Mine, explosives magazines, and South WRD. Noise levels in this location were found to range from 40.2 to 47.8 dB (A) with the highest at around 8:30 am. With the exception the current defined mineral resource area, all other areas are characterised by hills with farmlands and sparse populations and densely vegetated valleys
- **Study area 2:** Ore Processing Plant, ROM Pad, Workshop and Admin. These sites are generally classified as rural area with the same characteristics as the first study area. Noise levels in this are ranged from 40.0 to 46.6 dB with the highest at around 10:30 am
- **Study area 3:** TSF. These sites are generally classified as sparse rural villages with hills of open farming and grazing lands, dominated with densely distributed valley vegetation running along streams in the area. Noise levels in this area ranged from 40.7 to 47.4 dB with the highest at around 4:00 pm in the afternoon

The Project area is characterized by a combination of sparsely populated farmed hillsides. The hills are also used for grazing in some of the places. There are no industrial, commercial, transportation or dense traffic activities, music shops and the like that contribute to generation of noises in the area. Hence, the mean noise level in this area is 43.4 ± 0.8 dB(A) which as expected, falls below the guideline values of the Environmental Standards of Ethiopia (EPA, 2003). Note that the maximum level of noise for residential areas during the daytime is recommended to be 55 dB(A), however, there is no recommendation of maximum sound level for rural areas or for single noise events.

6. SOCIAL AND ECONOMIC BASELINE CONDITIONS

For the purposes of this Social Impact Assessment (“SIA”), a moratorium area slightly smaller than the mine lease boundary spanning a surface area of approximately 13.56 km^2 is considered an exclusion zone, meaning that no persons will be allowed to continue living or making use of the land and environment inside the mine lease boundary should the project be approved. The LSA was defined as a radius surrounding five kilometres from the Tulu Kapi Kebele, the Kebele in which mining exploration activities is underway.

Baseline data for this assessment was gathered for the socio-economic environment in the local study area using secondary sources, the sample quantitative household survey, and key stakeholder interviews and focus group discussions. A detailed socio-economic database for all project affected people is currently being finalised for use in resettlement planning, and livelihood restoration. The detailed data is in a Project Access database and will be provided to the local government for their use. Data will continue to be updated throughout the life of mine on a regular basis.

The socio-economic environment refers to a wide range of interrelated and diverse aspects and variables relating to or involving a combination of social and economic factors. Baseline information was categorised into demographic, social, economic, public services, and fiscal information. Data was collected on the social aspects including involvement in community activities as well as social and cultural attitudes and values; public services such as water, sanitation, communications, police and fire protection facilities, solid waste disposal as well as health and educational services; demographic data include population growth structures, distribution and density; economic factors include general characteristics, structures and changes in various economic activities and employment.

6.1.1. Regional Study Area

The regional study area includes the West Wollega Zone, and Genji Woreda in Figure 6-1:

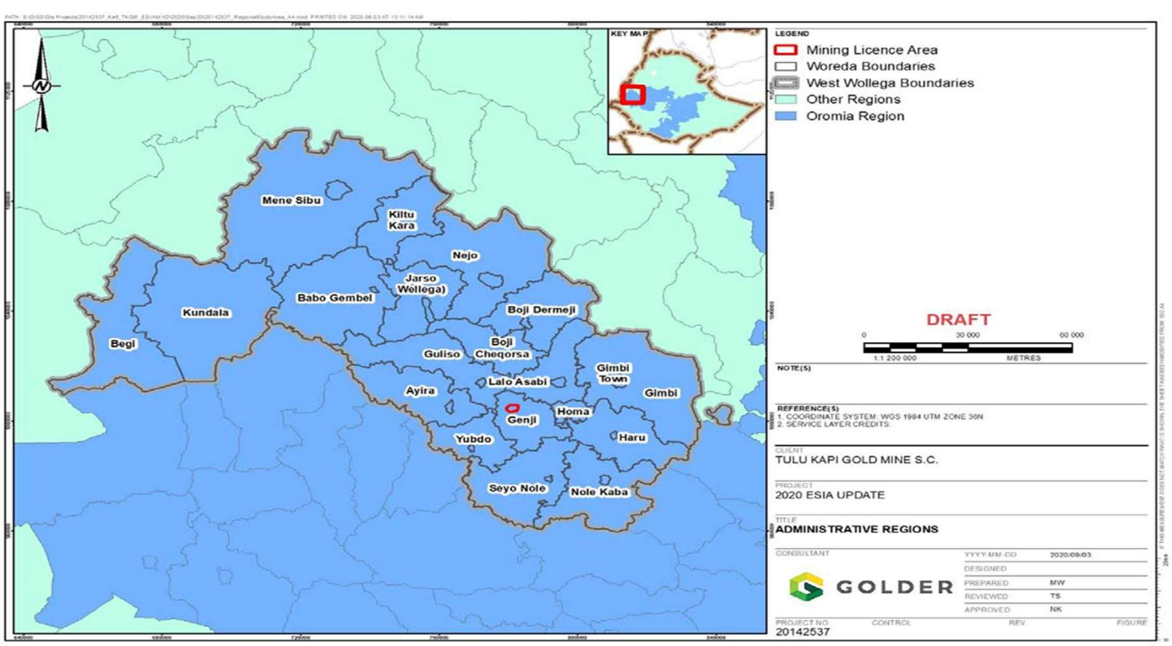


Figure 6-1: The regional study area includes the West Wollega Zone, and Genji Woreda

6.1.2. Administrative Structure

Tulu Kapi is in Oromia region, West Wollega Zone. Oromia region is the largest region in Ethiopia with a total population of 29 737 371 as of July 2010 (CSA, 2007) and an estimated average household size of 4.8 (CSA, 2007), with most of its population (88%) living in rural areas. It has 20 zones and 279 Woredas (districts). West Wollega Zone has a population of 1 480 362 as of July 2010 (CSA, 2010), with an average household size of 5.2 (CSA, 2007). It comprises 20 Woredas and 519 Kebeles.

Government administration operates in five levels as summarised in Table 6-1.

6.1.3. Population of the Project Woredas

The total population in Genji and Guliso Woredas is estimated at 66 383 and 76 482, respectively as of July 2010. Table 52 below shows the population disaggregated by gender.

Table 6-1: Population size of the Project Woredas

Woreda/ Kebele	2010		
	Total	*Male*	*Female*
Genji Woreda	66,383	33,016	33,367
Guliso-Wereda	76,482	38,094	38,388

The population in Genji and Guliso are predominantly young (younger than 19 years of age) - see Figure 6-2, indicating a dependency ratio of 1.2 children per adult for Guliso and 1.3 children per adult for Genji (assuming the age category of 0 – 19 as “children” and 20 and older as “adults”).

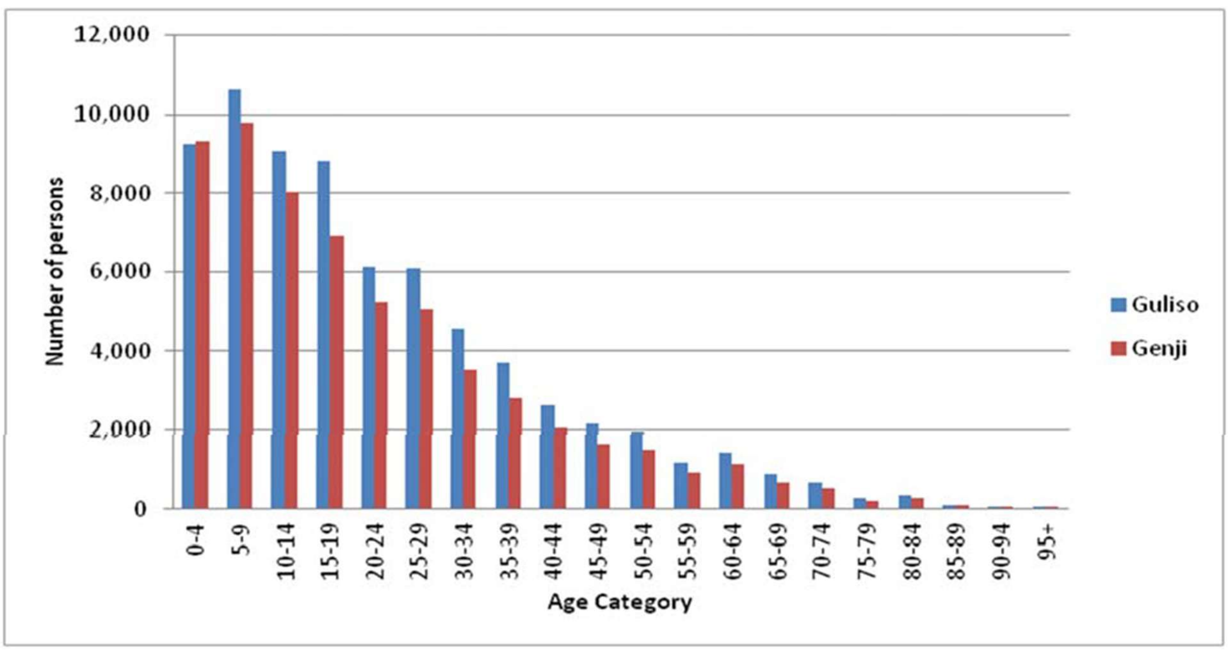


Figure 6-2: Age distribution for population in Guliso and Genji Woreda (CSA, 2007)

6.1.4. Health Service Coverage

Table 6-2 shows the number of health facilities of the Woredas.

Table 6-2: Health facilities in Genji and Guliso Woredas

Description	West Wollega Zone	Genji	Guliso
Hospital	3	0	0
Health Centre	16	1	4
Clinic	40	1	
Functioning Health Posts	187	13	22
Rural Drug Vendor	54	2	
Health Extension Workers		35	52
Health Extension Workers Supervisors	30	5	5

*Source: West Wollega Socio-economic Profile, Gengi and Guliso Woreda Health Offices

6.1.5. Education

The educational structure of Ethiopia has nine levels among which four are worth mentioning:

- **Kindergarten** focuses on all-round development of the child in preparation for formal schooling
- **Primary education** is eight years duration, offering basic and general primary education to prepare students for further general education and training
- **Secondary education** will be of four years duration, consisting of two years of general secondary education which will enable students to identify their interests for further education, for specific training and for the world of work for formal schooling. The second cycle of secondary education and training will enable students to choose subjects or areas of training which will prepare them adequately for higher education and for the world of work
- **Higher education** at diploma, first degree and graduate levels

In meeting the goal of education for all, efforts are underway at federal as well as regional levels to expand education service to the rural parts of Ethiopia (EDHS, 2005). The number of primary and secondary schools and the number of students attending school in the Genji Woreda and Guliso Woreda are presented in Table 6-3 and Table 6-4

Table 6-3: Number of schools and students in Genji Woreda

Description	Number of schools	Number of students	Student-Teacher Ratio	Student-Class Ratio
Primary 1st Cycle (1-4)	14	10,874	59:1	67:1
Primary 2nd Cycle (5-8)	9	5,547	45:1	55:1

Description	Number of schools	Number of students	Student-Teacher Ratio	Student-Class Ratio
9-10	1	1,961	37:1	69:1
11-12	1	108	9:1	35:1

*Source: Genji Woreda Education Office, 2010

Table 6-4: Number of schools and students in Guliso Woreda

Description	Number of schools	Number of students	Student-Teacher Ratio	Student-Class Ratio
Primary 1st Cycle (1-4)	13	12,119	54:1	55:1
Primary 2ndCycle (5-8)	26	8,294	27:1	56:1
9-12	2	3,614	38:1	78:1

*Source: Guliso Woreda Education Office, 2010

6.1.6. Agriculture

Agriculture is the main livelihood strategy in the RSA. The government is supporting households' agricultural livelihoods by assigning three agricultural Development Agents at the Kebele level (the lowest administrative level). The task of these Development Agents is to educate the households on the use of high yield seeds, fertilizers, insecticides, etc.

Most of the land in the Genji and Guliso Woredas is therefore utilised for agricultural activities, in line with the rural agricultural profile of the Oromia Region and the West Wollega Zone, and agriculture is the major livelihood activity for households. According to a March 2003 World Bank publication, the average rural household in the Oromia Region has 1.14 hectares of land compared to the national average of 1.01 hectares, 24% of the population are in non-farm related jobs compared to the national average of 25%.

Maize, millet and sorghum are the three major grain crops widely produced in the region (Table 56). These crops form the major staple crops for households, and therefore constitute the largest surface area of crops in the RSA. According to the socio-economic profile of the Woreda compiled in 2009, there have been no reported drought and relief aid for the Woredas. In West Wollega Zone, there were 487 farmer associations in 2008, and 423 farmers' service cooperatives. The cooperatives provide agricultural inputs, agricultural and industrial marketing services, credit, flourmill, saving, and modern crops storage services and facilities for the members. In Guliso Woreda, there were 26 farmers associations and 14 farmer's service cooperatives. The service cooperatives provide a market for their members by purchasing their products and supply of agricultural inputs. In Genji Woreda, there are 14 farmer associations, which provide services such as the provision of agricultural inputs like fertilizer, improved seed of different crops, herbicides pesticides, and saving and credit services.

Table 6-5: Major types of crops by area covered and production volume (Genji and Guliso, 2009)

Crop type	Woreda	Area covered (Hectare)	Production in quintals	Yield (qt/ha)
Maize	Genji	4 472	208 116	46.54
	Guliso	7 600	273 600	36.00
Millet	Genji	2 066	66 726	32.30
	Guliso	2 362	37 792	16.00
Sorghum	Genji	2 901	26 720	9.21
	Guliso	4 812	115 488	24.00

*Source: Genji and Guliso Woreda Agriculture Offices

In addition to crop farming mentioned above, the following also form part of major sources of income:

- Livestock and their products
- Beekeeping
- Coffee production
- Coffee, skin, and hides are the major exportable items produced in the West Wollega Zone

Low agricultural yields, use of traditional and outdated agricultural tools, depletion of forests resources, land and soil degradation, shortage of rural access roads for transporting modern agricultural inputs as well as agricultural production to the markets, shortage and variability of the amount and duration of rainfall, inefficient extension services, low application of modern agricultural innovations, lack of credit services and poor linkages between agricultural research and extension services are the major constraints of agriculture in the West Wollega Zone.

6.1.7. Local Study Area

The sections that follow provide a baseline of the LSA, primarily obtained from the results of the sample quantitative household survey. Information gained from secondary sources and focus group discussions are also utilised to supplement the data.

The LSA includes nine Kebeles which fall within a 5 km radius surrounding the Project area. The sample quantitative household survey included eight of these nine Kebeles, as the ninth (Boneyadobi) is affected primarily by the proposed road diversion and the socio-economic impacts to this Kebele are therefore expected to be limited. The impacts related to the road diversion are dealt with separately. Figure 80 below provides an overview of the LSA. Note that the mine lease area, which is 13.56 km^2 in extent, is considered an exclusion zone, meaning that no persons will be allowed to continue living or making use of the land and environment inside the mine lease area should the project be approved.

6.1.8. Population of Kebeles in and around the Project Area

The sample quantitative household survey covers 8 Kebeles, of which 3 are directly affected by the proposed Project and 5 are indirectly affected – see Table 6-6

Table 6-6: Population of Kebeles in LSA disaggregated according to gender

Woreda	Kebele	Directly/Indirectly Affected	Male Population	Female Population	Total Population
Genji Woreda	Bikiltuankuri	Directly affected	1 902	1 917	3 819
	Kapi Guracho	Directly affected	1 596	1 650	3 246
	Gudiya Guji	Directly affected	1 094	1 119	2 213
	Bekatohombaao	Indirectly affected	1 119	1 135	2 254
	Embraro Awenderi	Indirectly affected	863	869	1 732
	Mnjeembraro	Indirectly affected	821	897	1 718
Guliso Woreda	Jariso Biribir	Indirectly affected	1 922	1 952	3 874
	Segiya Guji	Indirectly affected	541	542	1 083
Total			**9 858**	**10 081**	**19 939**

*Source: CSA, projected as of July 2010

6.1.9. Ethnic Composition and Religious Affiliation

According to the sample household survey, the ethnic composition of the population in the Project area is all in all Oromo. Consequently, there are no ethnic minorities in the area that are defined as “Indigenous Peoples” in terms of ICF Performance Standard 5 and therefore in need of special protection. This is because the population living in the Project area are not deemed to possess the following characteristics:

- Self-identification as members of a distinct indigenous cultural group and recognition of this group by other
- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture
- A distinct language or dialect different from the official language or languages of the country or region in which they reside

The religious affiliation of the population in the Project area is also almost all in all protestant Christian with 96%, whereas Orthodox and Muslim constitute only 3% and 1% respectively. See Table 6-7 below.

Table 6-7: Religious affiliation of household heads and members

Religion	Household Heads		All Members	
	Number	Percent	Number	Percent
Protestant	450	94.1	2,614	96.0
Orthodox	22	4.6	80	2.9
Muslim	6	1.3	28	1.0
Total	**478**	**100.0**	**2,722**	**100.0**

6.1.10. Marital Status of Head of Households

The sample household survey determined that approximately 91.2% of household heads in the Project area are married, 6.7% are widowed, 1.3% are single, 0.4% are divorced and the remaining 0.4% are separated. Given that 91% of the household heads are male and married, any intervention done at the household level should consider the voice of most females who are not head of their households.

6.1.11. Literacy Status

Education is crucial element for development of a country or a community. With a goal of universal education for all, the government of Ethiopia is making concerted effort to expand access to education. It has been noted that there has been declining trend of illiteracy rate.

While the illiteracy rate has been decreasing among the youth, the effort is a relatively recent phenomenon to cut down the illiteracy rate significantly among adult population. As can be seen from Table 6-8 below, the sample household survey determined that nearly 57% of the surveyed household heads can read and write. This has implications should households be required to open and operate bank accounts or change the subsistence-based livelihoods to other livelihood strategies that require literacy.

Table 6-8: Literacy status of household heads

Read and Write	Number	Percent
Yes	272	56.9
No	200	41.8
Not Stated	6	1.3
Total	**478**	**100.0**

6.1.12. Age and Gender Composition

As rural Ethiopia is mainly a patriarchal society, the population of the Project area is mainly male headed. Out of the total of 478 household heads in the sample household survey, 92.5% are male headed. Only 7.5% the households are female headed households (see Table 6-9).

This probably reflects the traditional gender role of the society where males are the dominant decision makers within the household and are considered as head. This decision-making culture should be considered when undertaking resettlement planning activities in order to ensure the participation of vulnerable groups in the process.

According to the sample household survey, the average household size of the population in the Project area is 5.5 persons. The figure is slightly higher than the average household size of 5 in the Oromiya region (Population and Housing Census of Ethiopia, 2007).

Table 6-9: Gender of head of households in sample household survey

Sex	Number	Percent
Male	442	92.5
Female	36	7.5
Total	**478**	**100.0**

Of household heads, 18 percent are younger than 30 years of age (refer to Table 6-10). Approximately 25% of households are aged between 30 and 45 years, and approximately 20% of household heads are between 45 and 60 years of age. Approximately 10% are older than 60 years.

Table 6-10: Age of household heads

Age Group	Number	Percent
0-4	0	0
5-9	0	0
10-14	0	0
15-19	4	0.8
20-24	24	5.0
25-29	58	12.1
30-34	68	14.2
35-39	74	15.5
40-44	48	10.0
45-49	38	7.9
50-54	32	6.7
55-59	30	6.3
60-64	46	9.6
65 and Over	56	11.7
Total	**478**	**100.0**

Table 6-11 and Figure 81 provide the distribution of ages of household members. The population is predominantly young, with 59% of the population below 20 years of age.

Table 6-11: Age and gender distribution of household members

Age Category	Gender		Total	% of Total
	Male	Female		
0-4	174	160	334	12
5-9	260	234	494	18
10-14	222	240	462	17
15-19	162	126	288	11
20-24	102	96	198	7
25-29	96	136	232	9
30-34	82	68	150	6
35-39	76	58	134	5
40-44	50	20	70	3
45-49	38	28	66	2
50-54	24	58	82	3
55-59	26	22	48	2
60-64	38	24	62	2
65 and Over	41	15	56	2
Total	**1 391**	**1 285**	**2 676**	**100**

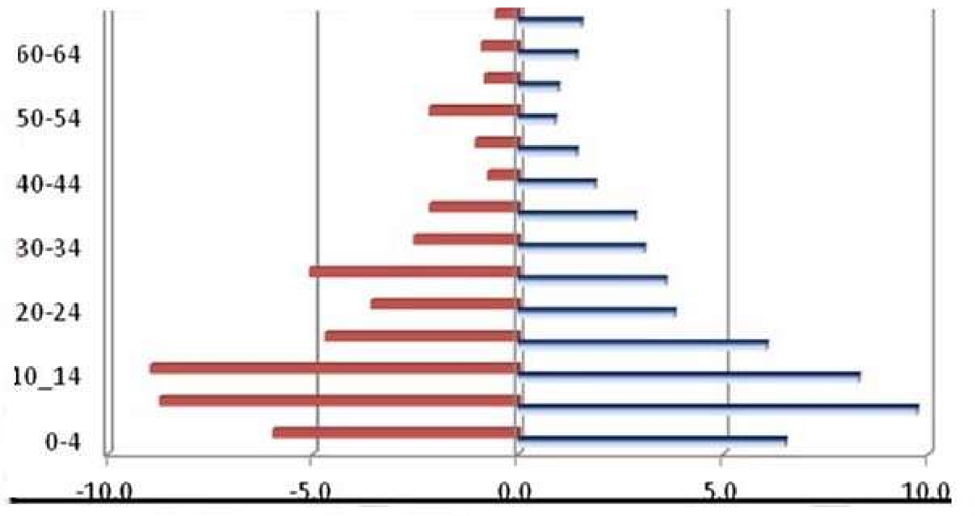


Figure 6-3: Age gender pyramid of the study population (females in red on the left and males in blue on the right)

6.1.13. Dependency Ratio

Dependency ratio, which is a useful approximation to economic dependency burden, can be obtained from age composition of the population. These ratios provide only approximation to economic dependency and do not necessarily mean that all persons in the so-called working age group do participate in the economic activity and that all persons outside these ages (say less than 15 years) are dependent.

The dependency ratio is, therefore, a measure of the portion of a population which is composed of dependents (people who are too young or too old to work). It is equal to the number of individuals aged below 15 or above 64 divided by the number of individuals aged 15 to 64, expressed as a percentage. This can give us a clue about the level at which young and old people depend on the assumed working adult population in the Project area within the age group of 15-64 years. The dependency ratio of the Project area is, therefore, found to be about 101.2% which is a little bit lower than the regional figure, 103.1% as depicted by the 2007 Population and Housing Census of Ethiopia. This means that for each 100 persons in the productive age groups there were about 101 young and old dependents to be supported.

6.1.14. Economic Activity Status

To ascertain the economic activity status, respondents aged ten years and older were asked in the sample household survey whether they were engaged in productive activities during most of the previous twelve months, and during the seven days prior to the day of the interviews. Where respondents indicated that they were engaged in productive activities in these timeframes, these individuals were considered economically active.

The economically active population comprises all persons of either gender who supply labour for the production of economic goods and services as defined by UN System of National Account during a specified reference period (UN, 2000). As the Ethiopian economy is predominantly agrarian, any labour related study conducted by the National Statistical Agency adjusts the lower age limit of the economically active population to 10 years of age in order to appreciate the contribution of the younger age population to the National System of Accounts.

Economic activity rate or economic participation rate is computed as the percentage of the economically active population over the total of the active plus non-active population aged ten years and over. Among the population aged ten years and older, the size of the economically active population was found to be 1 467 and that of the economically inactive population was 325 resulting in an activity rate of 82% (see Table 6-12). The high activity rate is an indication that most of the members in households are involved in the predominantly rural based (agrarian) livelihoods.

Table 6-12: Size of the project area population by activity status and age group

Age Group	Activity Status		Total
	Active	Inactive	
10-14	307	151	458
15-19	220	64	284
20-24	164	30	194
25-29	204	20	224
30-34	142	8	150
35-39	124	12	136
40-44	64	6	70
45-49	64	2	66
50-54	72	8	80
55-59	42	6	48
60-64	48	14	62
65+	16	4	20
Total	**1 467**	**325**	**1 792**

The area is characterised more prominently as a labour market rather than an employment market. In the sample household survey, the economically active persons were asked about the type of main economic activity in which they were engaged during the reference period. For the persons engaged in multiple economic activities, the activity that utilised the largest share of the time used was defined as the main type of activity. Table 6-13 below presents the percentage distribution of the economically active population aged ten years and over by the type of main activity (occupation). From the data in Table 6-13, at the highest proportion (38%) of economically active persons are engaged in agriculture while unpaid family workers constitute nearly 58% of the total economically active persons. Therefore, nearly 96% of the economically active persons are engaged in these two economic activities. The high proportion of unpaid family workers may be a result of the system of agricultural production where the wives, adult household members and young children help in the field as unpaid workers. In addition, over 95% of the household heads are also engaged in agriculture.

Table 6-13: Activity status

Description	Agriculture	Unpaid Family Worker	Government Employee	Others	Not Stated	Total
Number	564	844	18	26	15	1 467
Percentage	38.4%	57.5%	1.2%	1.8%	1.0%	100%

Life in these communities is labour intensive, often involving the entire family in the agricultural livelihood. Children are often involved in the sustainability of households, which is an indication of poverty in communities.

6.1.15. Household Income

With regard to the annual income of the households in the Project area, the sample household survey determined that approximately 54% of the households get an annual income of more than 2 400 Birr and about 23% of them get an annual income between 1 200 and 2 400 Birr (refer to Table 6-14). The median annual income of the rural households in the LSA was found to be 2 769 Birr, which is equivalent with a monthly income of 231 Birr.

Table 6-13: Annual income of surveyed households

Annual Income	Number	Percent
600 Birr and Less	20	4.2
601-1 200	88	18.4
1 201-2 400	112	23.4
2 401-4 800	124	25.9
4 801-12 000	62	13.0
12 001 and above	70	14.6
Not Stated	2	0.4
Total	**478**	**100.0**

6.1.16. Household Expenditure

With regard to the reported monthly expenditure of households (as per the sample household survey), 41% earn less than 500 Birr, 34% earn between 500 and 900 and the remaining 23% earn more than 900 Birr (refer to Table 6-15 :). The median monthly expenditure was calculated to be 562 Birr. Comparing the median monthly expenditure (562 Birr) with the median annual income (2 769 Birr, or a monthly income of 231 Birr), households have the tendency to overestimate their expenditure and underestimate their income.

Table 6-14: Monthly expenditure of households

Monthly Expenditure	Number	Percent
100 Birr and Less	8	1.7
101-300	68	14.2
301-500	122	25.5
501-700	134	28.0
701-900	36	7.5
901-1100	46	9.6
1101-1300	22	4.6
1301-1500	14	2.9
1500 and above	26	5.4
Not Stated	2	0.4
Total	**478**	**100.0**

6.1.17. Asset Ownership

The availability of various amenities and the ownership of different properties in a household are the most valuable indicator and it is associated with the quality of life of the household members. In the study, all the 478 households were asked whether they own the different items which are of interest to the study. Table 6-16: shows the number of households who responded to have owned the different items.

Table 6-15: Households by property ownership

Item	Yes	No	Not Stated	Total
Radio	204	254	20	478
TV	0	442	36	478
Telephone	38	408	32	478
Electric Mitad	0	446	32	478
Fridge	0	436	42	478
Bife and Sofa	24	384	70	478
Table and chair	426	48	4	478
Farmland	400	70	8	478
Cash Crop	338	130	10	478

Apart from the ownership of the above properties, the households were also asked whether they have livestock. Accordingly, about 58% of the households were found to own cows/oxen. According to informal discussions with respondents in the area, cattle are not considered an economic asset in this specific area (coffee fulfils this purpose). As can be seen in Table 6-17 below, chicken, donkeys and sheep are found to be owned by 57%, 32% and 28% of the households, respectively.

Table 6-16: Proportion of households by livestock holding

Livestock	Number	Percent
Cows/Oxen	276	57.7
Chicken	270	56.5
Donkeys	152	31.8
Sheep	134	28.0
Goat	32	6.7
Horses/ Mules	32	6.7

Based on these numbers, it can be concluded that the households included in the sample household survey are poor. Poor communities are less resilient and are more vulnerable to change. Displacement adds to the social risk for these households. It therefore becomes important for the Project to show benefits to the affected communities.

Type of Housing Units

Traditional housing units in rural Ethiopia are characterised by a round shape, mud walls and grass thatched roofs. Most of the housing units (95%) in the Project area have walls made of wood and mud, whilst the remainder (5%) have walls made from wood and grass (Table 6-18). About roofing, approximately 85% of the housing units in the Project area have corrugated iron roofs. The remaining 15% of the housing units have roofs made of grass (Table 6-19).

Table 6-17: Housing units by construction materials of walls

Wall Material	Number	Percent
Wood and Mud	452	94.6
Wood and Grass	24	5.0
Not Stated	2	0.4
Total	**478**	**5.0**

Table 6-18: Housing units by construction materials of roofs

Roof Material	Number	Percent
Corrugated Iron	406	84.9
Grass	70	14.6
Not Stated	2	0.4
Total	**478**	**100.0**

What is clear is that households mostly utilise natural materials to construct their houses and are therefore dependent on their natural environment for materials, an aspect that is often evident in poor communities.

6.1.18. Water and Fuel Source

The provision of safe water in Ethiopia is at its rudimentary stage. The sample household survey determined that almost 80% of the households do not have access to safe (treated and protected) drinking water. As can be seen in Table 6-20 nearly 66% of the households reported that they are using water collected from rivers or lakes or ponds for drinking. Even the other 14% reported using unprotected well or spring as their source of drinking water. The remaining 19% of the households surveyed obtain drinking water from protected sources (pipe or protected well/ spring). This means that any negative impacts that the proposed mining activities may have on the water quantity and quality in the Project area will have a significant negative impact on the community in the area.

Table 6-19: Source of drinking water

Source of Drinking Water	Number	Percent
River or Lake or Pond	314	65.7
Unprotected Well or Spring	66	13.8
Protected Well or Spring	58	12.1
Pipe inside the compound Common	16	3.3
Pipe outside the compound Common	12	2.5
Not Stated	8	1.7
Pipe inside the house	2	0.4
Pipe inside the compound Private	2	0.4
Total	**478**	**100.0**

With regard to main source of fuel for households approximately 88% of households use firewood and animal dung as their major source of energy (see Table 6-21). Coupled with the use of natural resources to construct household buildings, the reliance (and resulting pressure) on natural resources (specifically wood) is likely high.

Table 6-20: Main source of fuel for households in Project area

Fuel Source	Number	Percent
Wood/Cow Dung	422	88.3
Others	48	10.0
Not Stated	8	1.7
Total	**478**	**100.0**

6.1.19. Crop Production

Households in the Project area were also asked various questions in relation to crop production to understand food security situations, farming practices, use of fertiliser etc. According to the Woreda Agriculture Office, nearly 60% of the total land area of the Woreda is used for crop production and the three major crops produced in the Woreda are maize, millet and sorghum. Coffee is a major economic crop that is produced throughout Ethiopia, and this area is no different. As coffee most optimally grows in approximately 60% shade, shade trees are often planted specially to grow coffee underneath.

6.1.20. Trend of Crop Production

Among the questions asked during the sample household survey, one was the perception of households with regards to the trend of overall crop production in the last 5 years prior to the study. Most household heads (approximately 78%, refer to Table 6-22), responded that there was an increasing trend in overall crop production in the last five years. On the other hand, about 18% said that there was a decreasing trend in crop production over the period mentioned and about 3% reported that there was no any change at all.

Table 6-22: Trend of crop production in the last 5 Years

Trend	Number	Percent

Increased	372	77.8
Decreased	88	18.4
No Change	14	2.9
Not Stated	4	0.8
Total	**478**	**100.0**

6.1.21. Use of Fertilizer

Households in the sample household survey were also asked whether they use any method (fertiliser) to improve the fertility of the soil in the effort to get better production. Of the surveyed households, 87% mentioned that they use modern fertiliser, 80% mentioned that they use crop rotation, 36% used compost and 26% used fallowing to improve the fertility of the soil.

To see whether the use of fertiliser is related to the response of households with regards to the trend of overall crop production in the last 5 years, the use and non-use of fertiliser was cross tabulated with crop production trend. As the line graphs below show (see Figure 6-4), the trend in crop production (for the decreased and no- change category) is almost similar for fertiliser user and non-user households. There is, however, a marked difference in level, for example; only about 11-17% of fertiliser user households reported a decrease in crop production, while the figure is 25-41% for those households who did not use fertiliser.

Similarly, only less than 2% of fertiliser user households reported no change in crop production, while the figure is 5-38% for those households who did not use fertiliser.

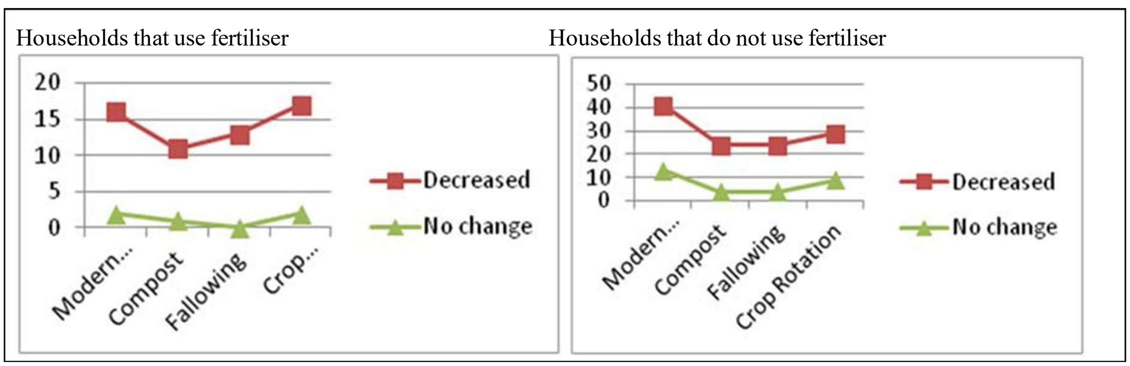


Figure 6-4: Use of fertiliser by households

6.1.22. Average Crop Production per Household by Crop Type

Data on the amount of crop produced by crop type during the last one year prior to data collection was collected from the households in the sample household survey. These households reported that the major crop that they produced was maize with total production of about 6 quintals per household. Sorghum, teff, barley and wheat were produced on an average of about 2 quintals per household. Figure 6-5 below shows comparison of the average amount (in quintals) of crops reported to be produced per household and production data obtained from the Woreda Agriculture Office for the year 2010. Except for maize, where there is a marked difference, the average production reported was similar. The difference in maize production was not investigated formally but could be related to agricultural production patterns in the LSA. As per the following section, most households reported that the food they produce is enough for household consumption, and coffee is the major cash crop that is produced in the Project area. There is therefore no need to produce high quantities of maize.

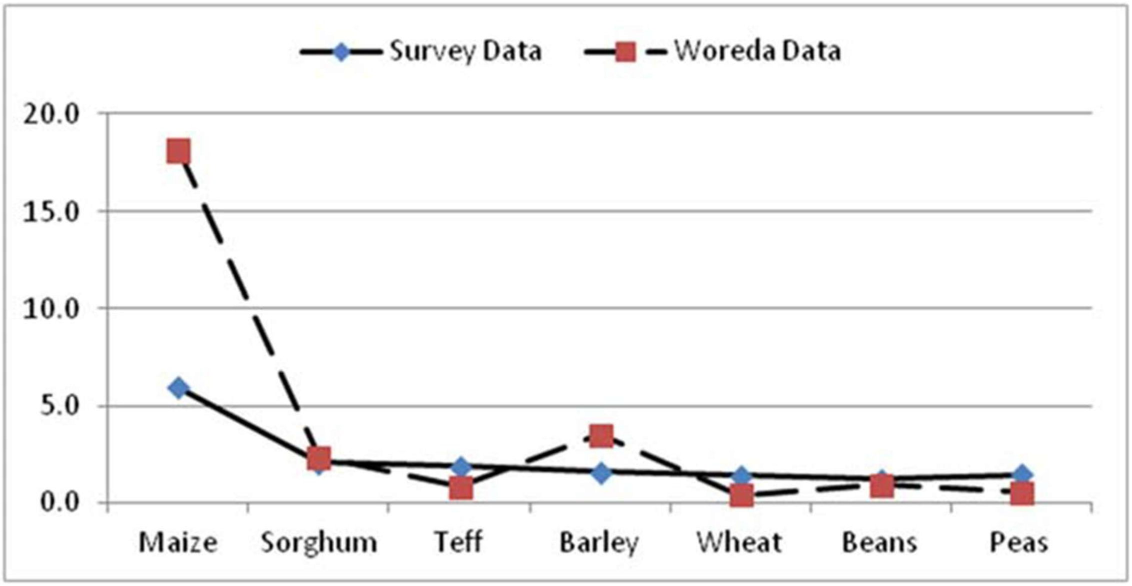


Figure 6-5: Data on the amount of crop produced

-A study undertaken by Haru (2009)[7] investigated the coffee production patterns in the Project area. This study determined that, ideally, one hectare of land can accommodate approximately 2 500 coffee trees, but that the Project area has approximately 3 333 trees per hectare. The more recent improved varieties of coffee can produce between 12 and 18 quintals (12 000 – 18 000 kg) of clean coffee per hectare under optimum conditions. It is estimated that in ideal circumstances 3 333 trees can produce nearly 12 000kg (12 quintals) of red fresh coffee cherries, which will yield approximately 8 000 kg (8 quintals) of jenfel coffee (dry coffee). This 8 000 kg will ultimately yield approximately 2 000 kg (2 quintals) of clean coffee per hectare. Therefore, each coffee tree can yield approximately 2.4 kg jenfel coffee per tree under ideal circumstances.

However, given the specific characteristics of the shading and soils in the Project area, the yields are much lower than that of ideal circumstances, averaging only 200 to 250 kg of clean coffee per hectare (0.2 – 0.25 quintals per hectare), which is approximately 0.36 kg jenfel coffee per tree. However, coffee trees yield in three- year cycles, with an average yield followed by a good yield, followed by a poor yield, followed by another average yield. These numbers are therefore averaging and may differ by year.

Given the total land use of 218 ha under forest cover (which is assumed to be used for coffee production), it is estimated that 727 594 coffee trees are in the SLA and that 262 quintals of red fresh cherries are produced. These fresh cherries are brought to the markets by the farmers where the coffee unions buy the coffee for further distribution and processing. This process will ultimately yield approximately 55 quintals of clean coffee. In addition, there is approximately 26 ha of forested/coffee plantation land within the proposed road realignment and power line routes.

6.1.23. Sufficiency of Crops Produced, Coping Mechanisms and Insufficiency Reasons

Households in the sample household survey were asked whether the crop that they had produced during the previous year was enough for their consumption – see Table 6-23. Accordingly, about 67% of the households responded that the crop they produced during the last one year prior to the study was enough to cover their household consumption. On the other hand, 31% of the households said that the production failed to be enough for their consumption.

Table 6-23: Sufficiency of crop production

Sufficiency of Crop	Number	Percent
Sufficient	322	67.4
Insufficient	148	31.0
Not stated	8	1.7
Total	**478**	**100.0**

The 148 households who responded that their crop production was insufficient to cover their consumption were asked to identify the various coping mechanisms they utilised. The three significant coping mechanisms mentioned by these households were the employment of family members, borrowing of money and the selling of livestock. Relief from governmental organisations/NGOs, and money received from children/relative were also mentioned but were less frequently utilised. Major factor reported to be responsible for the insufficient production by number of respondents are as depicted in Table 6-24 below.

Table 6-24: Coping mechanisms

Coping Mechanism	Number	Percent
Family members employed	58	39.2
Borrowed Money	50	33.8
Sold Livestock	32	21.6
Relief from GOs/NGOs	12	8.1
Money Received from Children/Relatives	8	5.4

The lack of land in the area was mentioned by most of the surveyed households (65%) as the main reason for the insufficient production (see Table 6-25). Pests and diseases were reported by nearly a third of the households as the reason for insufficient production. This reported lack of accessibility to land indicates that there is pressure on land in the Project area (as is also evidenced by the significant extent of land used for agricultural purposes). This poses a social risk to the Project as the loss of agricultural land may place additional pressure on households who are already struggling with access to land. Where households are displaced, provision of replacement will need to be considered as part of the RAP.

Table 6-25: Reasons for insufficiency of production for households reporting insufficient production

Reason for Insufficiency	Number	Percent
Lack of Land	96	64.9
Pests and diseases	46	31.1
Lack of Fertilizer	28	18.9
Bad Weather	26	17.6
Lack of Improved Seed	10	6.8

6.1.24. Road Diversion and Powerline Construction

The roads in the LSA include the public Guliso-Gangi road, and the construction of a new access road with an 18 m buffer between Genji and Keeley is proposed (refer to Figure 2-27). The public Guliso-Ganji road will require realignment around the north-western and south-western section of the exclusion zone, in Kapi Guracho kebele. The proposed new Genji-Keely road will be in Genji and Lalo Asabi/Inango Woredas, and will specifically affect four Kebeles: Kapi Guracho, Bikiltu Ankore and Boneyadobi Kebeles (in Genji Woreda) and a slight section of Keely Kebele from Lalo Asabi Woreda. At present both Woredas have no plan to construct roads in the affected Kebeles. The government is currently upgrading the road between Genji and Keely and this road serves as an alternative should TKGM opt not to construct an access road specifically for mine use between Genji and Keely. A decision on this option will be taken during the detailed design phase.

In addition, the construction of a powerline with an 18 m buffer between Keeley and Process Plant is proposed.

6.1.25. Social Infrastructure

Figure 85 below provides an overview of the social infrastructure in the mine lease area.

Within the MLA, 3 churches (all in Kapi Guracho Kebele), and 1 clinic (in Kapi Guracho Kebele) are located. Outside of the MLA, there are 2 schools (1 in Bikiltuankori Kebele and 1 in Kapi Guracho Kebele).

The clinic is currently busy with renovations. At the time of the writing of this report, new buildings were being erected (refer to Figure 6-6). The new building will include rooms where patients can be admitted.

The clinic has five clinical nurses, one public nurse and one midwife. However, no doctor is assigned to visit the clinic and there are no admission beds (a building for this is being constructed). There is one delivery bed and examination bed, a laboratory room and facility (with one assigned laboratory worker). The compound has water supply, but this does not extend to each room. Electricity is supplied y solar power. There are no sterilising machines, but disposable materials are used.

Figure 6-6: Guji Clinic in Kapi Guracho Kebele

Regarding education facilities, the LSA features a high student to teacher ratio (more than 70 children per teacher as per personal discussions with the Bikiltuankori Kebele administrator), with limited classrooms and children having to walk long distances to reach the schools. TKGM facilitated the establishment of a secondary school in Kapi Guracho kebele, which is located inside the exclusion zone, which is the closest secondary school in the area.

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Figure 6-7: Social infrastructure in the MLA

The LSA includes nine Kebeles, of which three are directly affected by the exclusion zone and an additional one Kebele is directly affected by the proposed road realignment. The LSA features an estimated 3 270 households with a population of 19 939 persons. Between 2012 and 2014, TKGM has undertaken significant efforts to reduce the mine footprint in order to minimise the extent of physical displacement, ultimately reducing the Project footprint by 38% and reducing the Project affected households from 486 to 260. These 260 affected households with an estimated 1 430 persons are located in the revised exclusion zone and will be physically displaced (it is understood that further efforts are being made to minimise the mine footprint to reduce the displacement even further). An unknown number of households located outside the exclusion zone may be utilising land inside the Project area, and this number of households will need to be confirmed in the RAP. As physical and economic displacement is considered one of the most significant negative socio-economic impacts, these efforts to minimise displacement demonstrate TKGM's adherence to IFC Performance Standard 5.

Households in the LSA are mostly poor, with few assets and low-income levels reported during the sample household survey. The livelihoods of the households in the LSA are predominantly land-based, growing maize, millet and sorghum for household consumption and coffee as the predominant cash crop. The lifestyle of these households is labour-intensive, often involving children in agricultural activities.

Land use in the Project area is predominantly agricultural, with 53% of the land utilised for agricultural cultivation purposes (comprising 371 ha). A further 31% (218 ha) of land is covered by forested areas, which are assumed to be used for coffee production. There appears to be pressure on the availability of land, and one-third of the households in the sample survey reported that they do not produce enough food to cover their household needs.

Whilst there are several churches, schools, and health centres in the various Kebeles in the LSA, 3 churches and 1 health centre are located inside the exclusion zone and will be physically displaced.

6.2. Cultural Heritage and Archaeological Resources

6.2.1. Historic and Cultural Context

The Project area is in a part of Wollega district characterized in part by exposed Precambrian rock, providing the region with rich metallic and non-metallic mineral resources (Woledemariam 1972; Hamrla 1966). There are artefacts and historical records referencing human mineral exploitation in the area, and subsequent trade interactions with other African and European trade routes (Cerulli 1933; Triulzi 1975; Ahmad 1999). Cattle and iron products from Wollega have been traced to market centers in the Gibe and Omo Valley, Durra, and the Sudan (Hassen 1990).

The Project area is close to Caaggo, a recognized ancient iron ore mining site. Historic iron ore mining, smelting, and smithing sites are evidenced by scars, slag, and tool fragments uncovered in Dimma, Yubdo Woreda; Winsa Qacoo, Ayira Woreda; and Caggo and Warra Qallu, Gulliso Woreda (Burka 2011; Hamrla 1966). Local Genji district and Ankori territory families traditionally known for pottery and metallurgy products dating back for more than 100 years include the Innagamdi, Innanani, Rufo and Baargii clans. Their widespread presence in Wollega underscores the area's association with traditional technology practices.

6.2.2. Identified Cultural Heritage Sites

Reconnaissance surveys were conducted in the Project area with the help of key locals. Cultural remains or features were identified, and 68 locations recorded, as listed below in APPENDIX O. A map of the findings is in Figure 6-8 below.

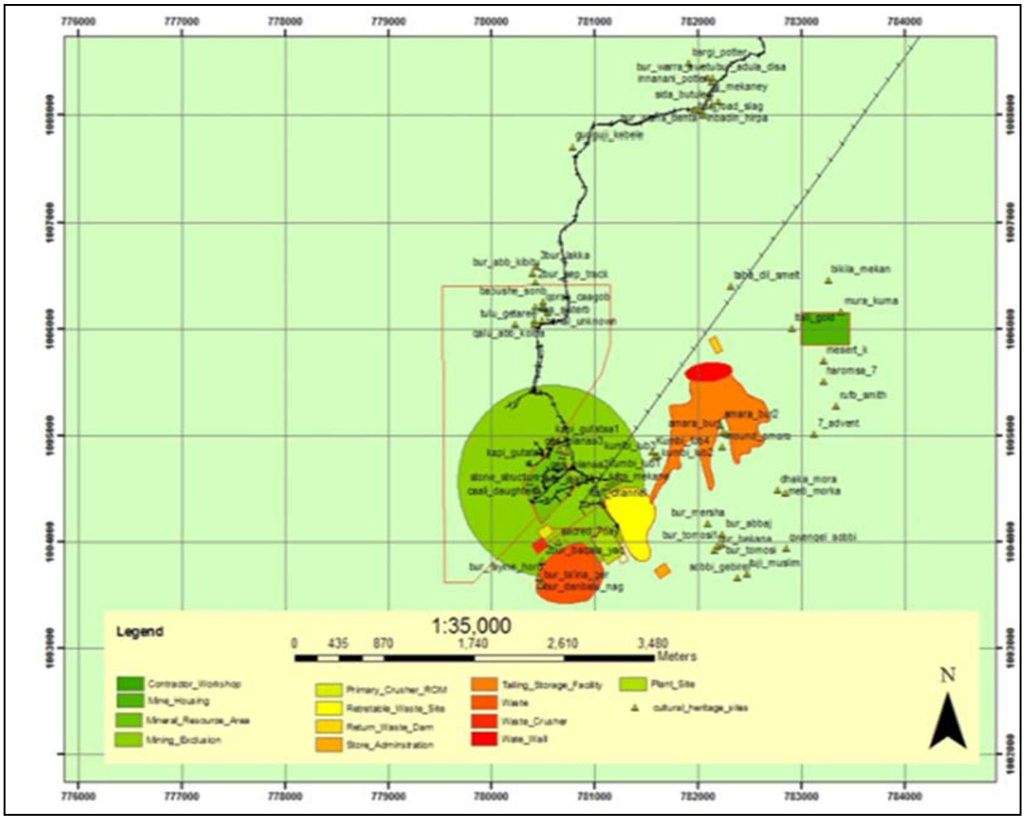

Figure 6-8: Cultural heritage map of the Tulu Kapi Project area (Note: Baseline data collection was conducted beginning in 2008; the project description has since been updated

6.2.3. Archaeo-Metallurgical and Archaeological Artefacts

Historic iron ore mining, smelting, and smithing sites can be identified by scars, slag, and tool fragments. Local members of the Rufo family, who are practicing metal smiths, identified archaeo-metallurgical artefacts from traditional metallurgy activity dating back for more than 100 years. The site identified by the Rufo family contained slag fragments from historic iron ore smelting.

This historic smelting site is located on the western side of the Ankori watershed. Although this site is no longer used for smelting, it has remained in use by traditional smiths for the procurement and storage of tuyères, the clay pipes used to connect leather bellows to traditional iron smelting furnaces. Clay tuyères can be reused indefinitely until they crack and break. Tuyères ranging from 30cm-1m in length have been documented in different parts of Wollega, particularly in Aira and Gulliso districts (Burka 2008). According to local informants, including the owner of the farm field and traditional smithies assisting the study team, practicing smiths' source historic clay tuyères dug from this site for reuse in active traditional furnaces.

A polished stone axe typical of the Neolithic period (circa 10,000 BCE) was in one of the ditches formed at an experimental drill site. The stone tool is flaked and fractured on the proximal side and served as a prototype for a metal axe with a sharp edge common in the region. Local informants identify the stone as dhagaasinbirro, or bird's stone, and state that such artefacts are common around Tullu Gettere, one the historic traditional worships sites in the region.

6.2.4. Historic Cultural Landscapes and Symbolic Sites

Human-environment interactions create cultural landscapes, some of which are of symbolic value. Symbolic sites can include worship places, sacred sites, burial sites, or all three. Several sites within the Project area would be classified as symbolic sites. Material signatures of Christian and traditional religious practice were identified at numerous sites of separate and overlapping symbolic significance belonging to both modern and traditional belief systems.

The small mountain of Tullu Dagala, overlooking Guracho River, is a significant traditional ritual site used in the Oromo spiritual traditions of Waqeffana. The Oromo of the surrounding areas traditionally gather on the mountain of Dagala to observe annual ceremonies, particularly that of Irrecha, or thanksgiving, during the month of September. Tullu Dagala is also the present-day location of two Protestant churches of different denominations and is one example of a cultural landscape in the Project area with overlapping traditional and modern symbolic value. A similar symbolic landscape is Tullu Gettere, is presently associated with management of indigenous trees of various species and intermittent coffee cultivation but is also a sacred site in Oromo traditional religious practice.

Of distinction is a traditional worship site identified on the eastern foothill of Tullu Getere known as Qaalluu Abba Kolbaa. Nearby are burial sites of family members of the Qaalluu. That the site is traditionally sacred is underscored by the presence of additional scattered graves in the farm field close to the Qaallu’s sacred site.

An additional landscape within the Project area altered by human-environmental interaction is Dhaka Mooraa, or the stone of Mooraa, which is a location of traditional religious practice. The name Dhaka Mooraa was derived from the traditional ritual practice of foretelling events using the fatty parts of animal intestines. A well-known clan in the Ankori area, near Sobbi Gabriel, is credited with this practice.

6.2.5. Modern Religious Sites

Christian churches in Genji district are identified as Ethiopian Orthodox (“EOC”) and Protestant churches. Protestant churches in this region are further sub-divided into multiple distinct denominations, indicative of a wide variability of religious belief systems and burial traditions within the local Christian communities.

6.2.6. Human Remains

Burial sites are dispersed throughout the Project area, and include traditional, Orthodox Christian, Protestant Christian, and Muslim graves. These sites were divided into two categories, namely those located in churchyards and those in isolated cemeteries on private farmsteads or in the compound of habitation sites.

Burial sites in three distinct locations were particularly considered. These include

Those of the families of Guttata and QesOlana
Those on the spines of Dirre Amara and Tomosi areas, as well as at Guracho, where the tailings will be located
Those in proximity of the dry weather road leading to Keeley/Innango

Some of these sites have already been affected by bulldozers within the Project area.

An isolated mound roughly 300 meters from Sobbi Gabriel church was identified as a cemetery belonging to a follower of Islam.

It was noted that burial sites are generally associated with land rights by the deceased’s relatives, and that subsequent economic and symbolic ties to burial sites were defended vigorously by residents.

7. ECOSYSTEM SERVICES

7.1.1. Introduction

Ecosystem services are the benefits that people, as well businesses such as TKGM, derive from ecosystems. These services are generally organised into four categories:

- Provisioning services – products, such as food, freshwater or timber, that people obtain from ecosystems
- Regulating services – benefits, such as climate regulation and surface water purification, that people obtain from the regulation of ecosystem processes
- Cultural services – non-material benefits that people obtain from ecosystems, such as natural areas that are scared sites or recreation
- Supporting services – natural processes, such as soil formation or nutrient cycling that maintain the other services

In most cases, the provision of these ecosystem services is underpinned by biodiversity which can be viewed as the natural capital.

The purpose of this ecosystem services baseline assessment was to conduct a systematic review in order to identify priority ecosystem services. In this context, there are two types of priority ecosystem services:

1) Services which are likely to be impacted upon by proposed Tulu Kapi Project and as a result adversely impact on affected communities
2) Services on which the proposed Tulu Kapi Project is or will be directly dependent on for its operations This baseline assessment was conducted using a combination of the following:
    - Initial desktop analysis using available spatial data (e.g. land cover map, surface water map and Google Earth)
    - Review of available literature (e.g. Stakeholder Engagement Report, Air Quality Report, Soils Report, Ecology and Biodiversity Report, Groundwater Report, Geochemistry Report, Cultural Heritage Report, and Socio-Economic Report)
    - Stakeholder engagement and consultation
    - In-field surveys

7.1.2. Nature and Extent of Ecosystem Services

The local study area is based largely on the boundary of mine lease area, while the regional study area or area of influence includes the streams and rivers downstream (up to the confluence with the next major stream) in order to account for potential impacts on water-related ecosystem services (see Figure 7-1).

Figure 7-1: Extent of ecosystem services supply

Most of the MLA has been transformed to cultivated fields (53% of total area), with only the rivers and Bushland (12%) that are still largely natural – see Table 25. As mentioned previously, the Forest areas (31%) are largely modified with the forest canopy having been reduced to few scattered individuals of selected woody species like *Polyscias fulva*, *Prunus africana*, *Apodytes dimidiata*, and *Schefflera abyssinica*, and the undergrowth replaced with coffee plants. These modified habitats still provide ecosystem services, albeit it at lower levels.

Table 7-1 below lists the Type I priority ecosystem services or ecosystem services which may be adversely affected by the Tulu Kapi Project:

Table 7-1: Type I priority ecosystem services

Ecosystem services	Description of service	Can service be substituted in a cost-effective way? *Y – Yes* *N – No* *? – Don't know*	Dependence on service *2 – High dependence* *1 – Medium to low dependence* *0 – No dependence*	Ecosystems which supply this service
Provisioning services				
Food from crops	Affected households plant range of crops including maize, tef, sorghum, and millet for household consumption, with the excess being sold for income. Some of the excess e.g. millet is also used animal feed during the dry season.	No	2	Cultivated land
Food from livestock	Affected households keep range of livestock including cattle, goats, sheep, donkeys and chickens. In general, it is only the chickens which are commonly used for food.	Yes	1	Cultivated land Bushland
Food from wild plants	Affected households supplement their food crops with food harvested from wild e.g. roots. This is generally done on *ad-hoc* basis.	Yes	1	Bushland Forest areas
Food from wild animals	Hunting wild animals, such as antelope, is an important source of meat for many affected households. Hunting is largely seasonal, occurring less frequently in the wet season when majority of household's time is allocated to growing crops.	No	2	Forest areas
Timber and other wood products	Affected households use timber for construction of buildings and fences, and another household uses. This timber is generally	No	2	Cultivated land Forest areas

Ecosystem services	Description of service	Can service be substituted in a cost-effective way? *Y – Yes* *N – No* *? – Don't know*	Dependence on service *2 – High dependence* *1 – Medium to low dependence* *0 – No dependence*	Ecosystems which supply this service
	harvested from gum plantations planted near homesteads, with some timber being harvested from forest areas.			
Fibres	While the majority of affected households use corrugated iron for roofing, there are some households which still use thatching grass.	Yes	1	Bushland
Sand	Almost all the affected households use clay, often mixed with grass, to plaster the walls of their buildings.	No	2	Rivers Regional roads (cut and fill exposes clay)
Biomass fuel	Affected households largely use gum planted around the homesteads for fuel wood. Old, dying trees in the Forest areas are also harvested for fuel wood. In some cases, dried millet is also used for fuel wood.	No	2	Cultivated land Forest areas
Freshwater	Affected households generally collect freshwater from springs and streams near their homesteads. Further to this, downstream areas are also dependent on supply of freshwater from the mine lease area which contains the headwaters of several small streams.	No	2	Rivers

Ecosystem services	Description of service	Can service be substituted in a cost-effective way? *Y – Yes N – No* *? – Don't know*	Dependence on service *2 – High dependence* *1 – Medium to low dependence* *0 – No dependence*	Ecosystems which supply this service
Natural medicinals	In general, affected households prefer to use natural medicinals to treat common ailments (e.g. upset stomach) before going to the local clinic where they have to pay for medicine.	Yes	1	Forest areas
Regulating services				
Regulation of air quality	Except for a narrow band along existing roads where dust is an issue, air quality in the mine lease area is generally good.	No	1	Cultivated land Bushland Forest areas Rivers
Local, regional, and / or global climate	At local level, the Forest areas create a micro-climate which is favourable for the growing of coffee trees, an important cash crop for majority of affected households.	No	2	Forest areas
Water timing and flows	As mentioned earlier, households generally collect freshwater from springs and streams near their homesteads. As there is little or no piped water in the area, it is critical that flows from these water resources is maintained year-round, particularly during the dry season. Further to this, downstream areas are also dependent on year-round flows from the mine lease area which contains the headwaters of several small streams.	No	2	Rivers

Ecosystem services	Description of service	Can service be substituted in a cost-effective way? *Y – Yes N – No* *? – Don't know*	Dependence on service *2 – High dependence* *1 – Medium to low dependence* *0 – No dependence*	Ecosystems which supply this service
Erosion control	Soils in the mine lease area general have erosion risk due to steep slopes and soil types. In addition to use of contour ploughing and terracing, groundcover plays an important role in the prevention of erosion, and loss of valuable topsoil.	No	1	Cultivated land
Water purification and treatment	As mentioned previously, there is little or no potable water supply in the area. Affected households are therefore dependent on the ability of ecosystems to purify and treat the water which they use. Further to this, downstream areas are also dependent on supply of clean water from the mine lease area which contains the headwaters of several small streams.	No	2	Forest areas Bushland Cultivated land Rivers
Regulation of pests and diseases	While majority of livestock are vaccinated, the ecosystems in the mine lease area still play an important role in regulation of pests and diseases.	Yes	1	Forest areas Bushland Cultivated land Rivers
Regulation of soil quality	In combination with sustainable farming techniques, such as rotational cropping and burning of crop residues, ecological processes play an important role in maintaining soil fertility.	Yes	1	Cultivated land

Ecosystem services	Description of service	Can service be substituted in a cost-effective way? *Y – Yes N – No* *? – Don't know*	Dependence on service *2 – High dependence* *1 – Medium to low dependence* *0 – No dependence*	Ecosystems which supply this service
Pollination	A number of affected households have fruit trees, such as Mango and Avocado, as well as vegetables which are pollinated by wind, bees and other insects.	No	1	Forest areas Bushland
Supporting services				
Habitat	Ecosystems provide habitat for wild plant and animal populations which benefit the affected households, as well as populating areas outside of the mine lease areas. Furthermore, these habitats also protect the capacity of these populations to recover from disturbances.	No	2	Forest areas Bushland Rivers
Cultural services				
Spiritual values	Within the mine lease area, there are a number of natural areas that are sacred sites. For example, Tullu Dagala, overlooking Guracho river, is a significant traditional ritual site used in the Oromo spiritual traditions of Waqeffana.	No	2	Forest areas Bushland Rivers

Table 7-2 below lists the Type II priority ecosystem services or ecosystem services on which the proposed Tulu Kapi Project is or will be directly dependent on for its operations:

Table 7-2: Type II priority ecosystem services

Ecosystem services	**Description of service**	**Can service be substituted in a cost-effective way** ***Y – Yes*** ***N – No*** ***? – Don't know***	**Dependence on service** ***2 – High dependence*** ***1 – Medium to low dependence*** ***0 – No dependence***	**Ecosystems which supply this service**
Provisioning services				
Timber and other wood products	Numerous buildings, particularly in the mine camp, will be constructed using timber harvested from the gum plantations or cleared forest areas.	Yes	1	Cultivated land Forest areas
Sand	Numerous buildings, particularly in the mine camp, will be constructed using sand and clay harvested from within the mine lease area. Furthermore, topsoil from disturbed areas will be stockpiled and later used in rehabilitation for topdressing on disturbed areas.	No	2	Cultivated land Bushland Forest areas Rivers
Freshwater	Freshwater for the Project will be abstracted from the Raw Water Diversion Dam.	No	2	Rivers Dam (i.e. RWDD)
Regulating services				
Regulation of air quality	The Project will be dependent on ability of ecosystems, particularly aquatic ecosystems, to trap dust generated by mining operations.	No	2	Bushland Forest areas Rivers Dam

Ecosystem services	Description of service	Can service be substituted in a cost-effective way *Y – Yes* *N – No* *? – Don't know*	Dependence on service *2 – High dependence* *1 – Medium to low dependence* *0 – No dependence*	Ecosystems which supply this service
Water timing and flows	In addition to being dependent on sustained flows into the RWDD, particularly during the dry season, the Project will also be dependent on ability of landscape and ecosystems to attenuate floods which could threaten mine infrastructure, particularly the TSF.	No	2	Bushland Forest areas Rivers Dam TSF
Water purification and treatment	The Project will be dependent on the ability of ecosystems to treat and purify water in order to minimise impact of mining operations on downstream water users.	No	2	Rivers Dam TSF
Supporting				
Habitat	The Project will be dependent on remaining ecosystems within the mine lease area to maintain wild plant and animal populations, and to protect the capacity of these populations to recover from disturbances.	No	2	Bushland Forest areas Rivers
Cultural				
Spiritual values	It is proposed that where possible, natural areas that are sacred sites, will be protected.	No	2	Cultivated land Bushland Forest areas Rivers

7.1.3. Condition, Trends and Threats to Ecosystem Services

Table 7-3 below presents a statement on the condition, trend and external or non-project threats to identified Type I priority ecosystem services.

Table 7-3: Condition, trends and threats to Type I priority ecosystem services

Ecosystem services	Condition *2 – Very good* *1 – Good* *0 - Poor*	Trend *(+) - Positive* *(-) – Negative* *(?) – Don't know*	Threats
Provisioning services			
Food from crops	2	+	Overexploitation Poor farming techniques Hydrological changes
Food from livestock	1	-	Overgrazing Hydrological changes
Food from wild plants	1	?	Overharvesting Habitat loss, degradation, and fragmentation
Food from wild animals	1	?	Overhunting Habitat loss, degradation, and fragmentation
Timber and other wood products	1	+ (i.e. planting of gum)	Overharvesting Habitat loss, degradation, and fragmentation
Fibres	1	-	Habitat loss, degradation, and fragmentation
Sand	1	-	Overgrazing Poor farming techniques Hydrological changes
Biomass fuel	2	+ (i.e. planting of gum)	Overharvesting Habitat loss, degradation, and fragmentation
Freshwater	2	-	Pollution Nutrient loading Hydrological changes
Natural medicinals	1	?	Overharvesting Habitat loss, degradation, and fragmentation
Regulation services			
Regulation of air quality	1	-	Habitat loss, degradation, and fragmentation
Local, regional, and / or global climate	1	-	Habitat loss, degradation, and fragmentation

Ecosystem services	Condition *2 – Very good* *1 – Good* *0 - Poor*	Trend *(+) - Positive (-) – Negative (?) – Don't know*	Threats
Water timing and flows	2	-	Hydrological changes Overgrazing Habitat loss, degradation, and fragmentation
Erosion control	1	-	Overgrazing Poor farming techniques Hydrological changes Habitat loss, degradation, and fragmentation
Water purification and treatment	2	-	Pollution Nutrient loading Hydrological changes
Regulation of pests and diseases	1	?	Pollution Nutrient loading Habitat loss, degradation, and fragmentation
Regulation of soil quality	2	+	Overgrazing Poor farming techniques Hydrological changes Habitat loss, degradation, and fragmentation
Pollination	1	-	Habitat loss, degradation, and fragmentation
Supporting services			
Habitat	1	-	Habitat loss, degradation, and fragmentation
Cultural services			
Spiritual values	1	-	Habitat loss, degradation, and fragmentation

In summary, the condition of priority ecosystem services is either good or very good, with most services experiencing a negative trend. Note there are some services which are experiencing a positive trend, as result of increased area under cultivation, improved farming techniques, and planting of gum trees around homesteads. Overexploitation and habitat loss, degradation and fragmentation are key non-projects threats to the identified priority ecosystem services. With climate change, hydrological changes are likely to also become a key threat to services in the future.

7.1.4. Beneficiaries of Ecosystem Services

There are several beneficiaries or users of ecosystem services generated within the mine lease area. This includes the following:

- Affected households – households situated within the boundaries of the mine lease area
- TKGM – Company responsible for constructing and operating the TKGP
- Downstream beneficiaries – Households situated downstream of mine lease area which are

dependent on water-related ecosystem services e.g. freshwater

- Regional beneficiaries – Households situated outside of the mine lease area that benefit from ecosystem services generated within the mine lease area. This includes for example, households that
- have cultivated fields or coffee plantations in the mine lease area or local traders who purchase food crops or coffee from affected households
- National and international beneficiaries – The mine lease area is located within an important coffee growing region, which in addition to supplying coffee to local market, also supplies global coffee market

8. ENVIRONMENTAL AND SOCIAL IMPACTS

The environmental and social implications of the project, both positive and negative, are discussed in this chapter, both directly and indirectly. The project description, which is summarized in Chapter 2, and knowledge of the environmental and social context, which are summarized in Chapters 5 and 6, serve as the foundation for the assessment.

The arrangement in which the chapter's sections are presented makes it easier to make comparisons between impact discussions. Table 8-1, which also evaluates effects on prioritization, summarizes the topic headings and impacts addressed in this chapter. It should be emphasized that this chapter discusses some non-priority ecosystem services; in these cases, the impact has been excluded from the ecosystem services impact assessment but is still there from an environmental or social impact standpoint.

The methodology outlined in Chapter 4 is used to evaluate impacts. An impact rating table follows the discussion of each impact. Each project phase's initial and residual impact ratings are provided, along with a list of management steps that must be taken to avoid or lessen unfavourable effects while maximizing positive ones. The initial impact rating considers the impact management strategies included into the project's design. The project design measures and supplementary management initiatives to reduce adverse effects or increase advantageous effects are both taken into consideration when calculating the residual impact rating. These suggestions are given as pledges because TKGM will put them into action. The Environmental and Social Management Plan (Chapter 8) has been updated to include the management practices taken into account during the impact assessment.

The information which is presented below is a consolidation of the identified impacts associated with the proposed TKGM. These impacts have been sourced from various specialist reports and each section of this study approach is based on the Ethiopian as well as IFC PS requirements.

Table 8-1: Identified Potential Impacts Grouped by Topic

ID #	Topic	Ref. code	Potential impacts discussed	Section
1	Air Quality	AR01	Increased air emission	7.1
2	Climate	CC01	Increased greenhouse gas emissions	7.2
3	Noise	NO01	Increased Noise level	7.3
4	Surface water	WR01	Discharges or runoff to surface water affecting water quality	7.4.1
		WR02	Altered surface water flow regimes	7.4.2
		WR03	Seepage from mining wastes	7.4.3
		WR05	Unplanned spills or discharges affecting water quality	7.4.4
5	Groundwater		Groundwater level and quality	7.5
6	Soils and land capability	SL01	Disturbance of Soil and Erosion	7.6.1
		SL02	Soil Contamination Due to Leaching of Soluble Chemical Pollutants	7.6.2
7	Biodiversity	BD01	Habitat loss and fragmentation	7.7.1
		BD02	Changes in surface water flows affecting Ecological Receptors	7.7.2
		BD03	Habitat Alteration - Increased Colonisation by Exotic Species and Introduction of AIS	7.7.3
		BD04	Habitat alteration – attractive nuisance and alien invasive species	7.7.4
8	Economy and Employment	EE01	Increased government revenue and capital infusion	7.8.1
		EE02	Direct employment generation	7.8.2
		EE03	Indirect and induced employment generation	7.8.3
		EE04	Influx of Population	7.8.4
		EE05	Physical and Economic Displacement	7.8.5
		EE06	Increased Pressure on Existing Ecosystem Services	7.8.6
		EE07	Physical and Economic Displacement	7.8.7
9	Social and Cultural Cohesion	SC01	Increased marginalization of vulnerable groups	7.8.2
10	Community Health and Safety	CHS01	Increased disease prevalence within employees and communities	7.9.1
		CHS02	Creation of permanent surface water feature increasing malaria prevalence	7.9.2
11	Archaeology and Cultural Heritage	AC01	Damage or loss of tangible and intangible cultural heritage	7.10.1

8.1. AIR QUALITY IMPACTS

This section reviewed and updated the Golder Associates Africa ltd. report on the Air quality impact Assessment (Golder 2020). It provides an overview of the sources and receptors taken into account in the assessment (Section 7.1.1), as well as an explanation of the procedures used to assess project-related air emissions (Section 7.2.1), before evaluating the impacts.

8.1.1. Emission Inventory

The establishment of an emissions inventory forms the basis for any air quality impact assessment. Air pollution emissions may typically be obtained using actual sampling at the point of emission or estimating it from mass and energy balances or emission factors which have been established at other, similar operations. The method adopted here is the latter. Emission factors published by the US-EPA in its AP-42 document "Compilation of Air Pollution Emission Factors" and Australian National Pollutant Inventory "Emission Estimation Technique (EET)" manuals were used.

According to USEPA – AP-42 (2016)," air pollutant emission factors are representative values that attempt to relate the quantity of a pollutant released to the ambient air with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per mega gram of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality and are generally assumed to be representative of long-term averages".

The general equation we used to compute emission rate based on an activity is the following:

$$E = A * EF * \left(1 - \frac{ER}{100}\right)$$

Where: E = emission rate

A = activity rate

EF = emission factor

ER = emission factor reduction efficiency (%)

An emissions inventory was established comprising emissions from project activities at the proposed Tulu Kapi Mining Project with implication on ambient air quality. The establishment of this emissions inventory is necessary to provide the source and emissions data required as input to the dispersion simulations.

8.1.2. Overview of Sources and Receptors

8.1.2.1. Sources of air emissions

Potential sources of emissions generated by the project include:

- Construction activities
  - Land clearance and earthwork activities (wind erosion of exposed areas).
  - Movement of vehicle and Mobile equipment
  - Generators and other stationary equipment.
- Mining and processing Operations
  - Land clearance and earthwork activities (wind erosion of exposed areas).
  - Drilling and blasting within the open pits.
  - Movement of vehicle, trucks and Mobile equipment.
  - loading/unloading facilities,
  - ROM site and crushing operation
  - Increased human activity in project area.
- Restoration and closure

The mine will be decommissioned and shut down when mining and processing are finished in an effort to reduce the possibility of exposed surfaces having long-term effects. It is anticipated that the equipment used during construction will be similar to that utilized during decommissioning and restoration activities.

8.1.2.2. Receptors

The Project region is distinguished by sparsely settled, agricultural hillsides with sporadic communities all over. There are no heavy traffic, industrial, commercial, or transportation operations in this area. The area is therefore primarily used for agriculture. The slopes are terraced for the seasonal production of maize, teff, corn, and other commodities. The ridges are primarily allowed to graze for livestock. A forest habitat covers the incised valleys, providing shade for vast coffee plantations, the region's primary cash crop.

The United States Environmental Protection Agency ("USEPA") defines sensitive receptors as places where people are more vulnerable to the negative consequences of exposure to pollutants. The following are only a few of these areas:

The United States Environmental Protection Agency ("USEPA") defines sensitive receptors as places where people are more vulnerable to the negative consequences of exposure to pollutants. The following are only a few of these areas:

- Household areas
- Hospitals/clinics
- Education and childcare institutions
- Senior housing

Within a 10 km radius of the mining licence area ("MLA"), the following sensitive receptors were found to be relevant for this investigation and are shown in Table 8-2 and Figure 8-1

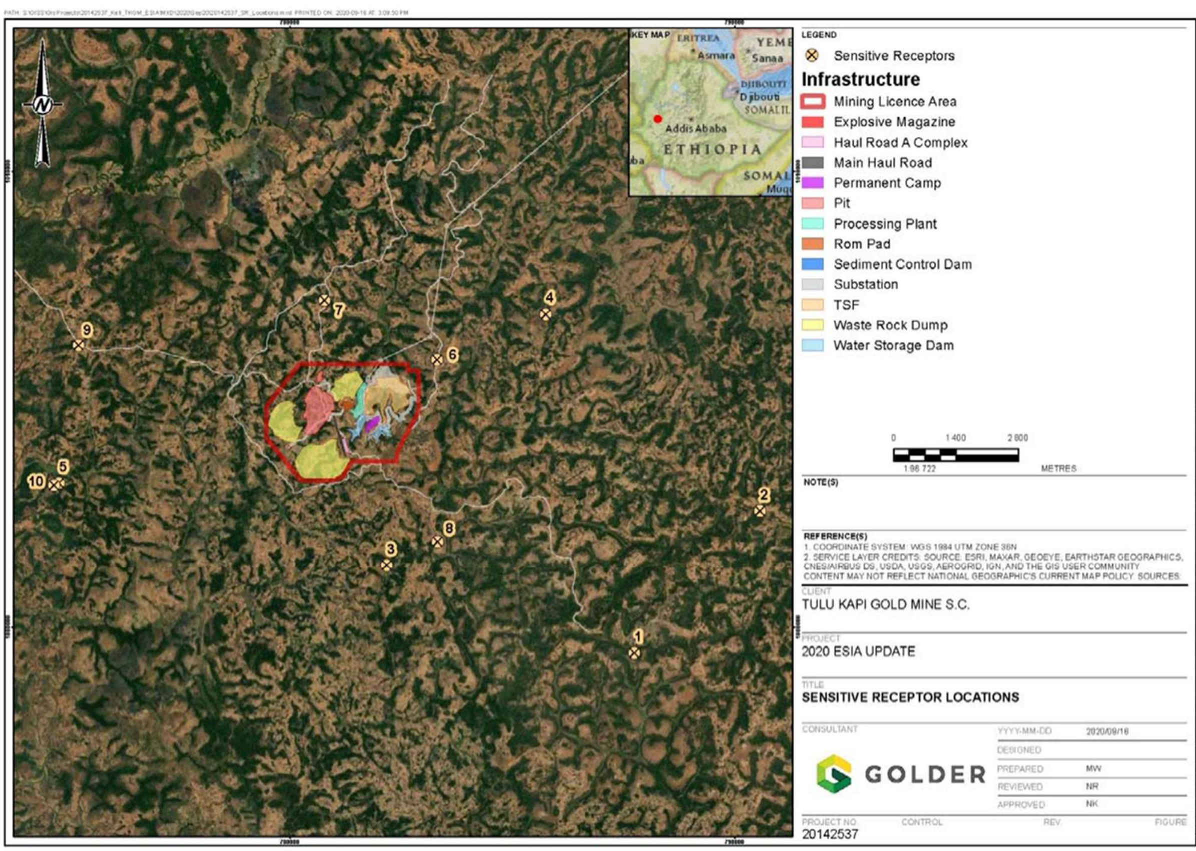

Figure 8-1: Sensitive receptors for the TKGP within a 10 km radius (Golder 2020)

Table 8-2: location of sensitive receptor

8.1.3. Potential Impacts

ID	Name	Receptor Type	UTM Coordinates		Distance from Site (km)	Approximate Direction from Site
			mE	mN		
1	Gengi Town	Residential	787757.00	999430.00	6.7	South-East
2	Mint'e Town	Residential	790584.00	1002557.00	7.9	East-South-East
3	Manete Village	Residential	782189.00	1001358.00	2.2	South
4	Dubdo Village	Residential	785759.00	1006870.00	3.1	North-East
5	Guji Village	Residential	774820.00	1003167.00	4.8	West-South-West
6	Biqiltu Hankore Hospital	Hospital	783324.00	1005876.00	0.6	North-East
7	Gudaya Hospital	Hospital	780787.00	1007174.00	1.5	North
8	Embaro Awnderi Hospital	Hospital	783330.00	1001884.00	2.2	South
9	Jarso Biribir Hospital	Hospital	775265.00	1006188.00	4.4	North-West
10	Kercha Primary Hospital	Hospital	774709.00	1003124.00	5.1	West

8.1.3.1. Construction

The main construction activities for TKGP involve site preparation including site clearing, removal of topsoil and vegetation as well as landscaping. USEPA AP-42 recommend the quantity of dust emissions to be proportional to the size of area of land, silt content of the soil and inversely proportional to the moisture content of the soil. The following equation is used to estimate TKGP construction phase emission:

E_{TSP} =2.69 *10^6 g/ha/month of activity

The emission factor relates the tons of TSP emitted per hectare covered by construction activities per month of activity. Based on the USEPA particle size distribution data, PM10 and PM2.5 constitute 35% and 5.3% of TSP, respectively. A control efficiency of 50% (NPI, 2012) has been applied for water sprays, as per Client data. Accordingly for an 8-hour per day operation ER_{TSP} will be:

E_{TSP} = [2.69*10^6 g/(10,000m^2 *8*30*3600 s)] *50%

= 1.56E-04 g/m^2/s

E for PM_{10} and $PM_{2.5}$ is estimated as 35% and 5.3% of TSP respectively. As a result PM_{10} will be estimated 5.45E-04 and $PM_{2.5}$ to be 8.25E-06.

Table 8-3: Calculated emission rates for the construction phase (TS Environment 2023)

Location	Emission Rate (g/m²/s)		
	TSP	PM10	PM2.5
Construction at the mine	1.56E-04	5.45E-05	8.25E-06

During the construction phase, with the implementation of mitigation measures such as water sprays, the impact is anticipated to improve significantly in comparison to that with no mitigation measures in place. The impact, with mitigation measures has a medium probability of occurrence, is only expected to reach a local extent, with a low magnitude and is also short-lived and transient in nature, resulting in a "low" significance.

Fugitive particulate emissions are anticipated to be the dominant emission from the main open pit during the construction phase. These emissions, however, are anticipated to be short-lived and limited to the immediate vicinity of the mining licence area.

Given the climatic regime, exceedances are not likely to occur during the rainy season. There are no anticipated air quality impacts for the construction phase which serve as a fatal flaw for the proposed mine's development. Nevertheless, suitable mitigation measures are recommended to reduce the nuisance factor of the emissions and aid in ensuring compliance with international requirements.

8.1.3.2. Operational Phase

Emission sources that will be expected in TKGP operational phase may arise from the following activities:

- Drilling
- Blasting
- Gold ore crushing
- Material handling operations
- Vehicle entrainment from unpaved roads
- Wind erosion from exposed surfaces

Drilling

The emission factor for TSP associated with drilling has been applied in accordance with the NPI Emission Estimation Technique Manual for Mining (NP1). The calculation relates the amount of TSP emitted (kilograms) per hole that is drilled. The calculated emission rates for drilling are presented in Table 5-1. The following equation was used to estimate the drilling emission factor.

$E_{TSP} = 0.59\ kg/hole$

The calculation relates the amount of TSP emitted (in kilograms) per hole that is drilled. As per Client data, 170 holes will be drilled per day. To determine the PM10 and PM2.5 emissions rates, a factor of 52% and 3% was applied respectively to the TSP equation (USEPA, 2006). A control efficiency of 70% (NPI, 2012) for use of wet suppression, as per Client data, was applied to emissions from drilling. The calculated emission rates for drilling is given in Table 17 for a 24-hour operation, 7 days a week.

Hence; E_{TSP} =(0.59*1000g*170*0.3)/(24*3600) =0.348 g/s

Table 8-4: Emission rate due to drilling

Source	Emission Rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Drilling	3.48E-01	1.81E-01	1.04E-02

Blasting

In general, two types of emissions are generated from blasting. The detonation of the explosives and the associated chemical reactions will result in emissions of compounds such as SO2, NOx and CO, coupled with fugitive particulate emissions. Data on the estimated amount of ammonia nitrate mixed with fuel oil (ANFO) and emulsions were not available, hence gaseous emissions from blasting were not quantified.

Fugitive particulate emissions resulting from blasting were calculated using the Equation below (AP-42).

$$E_{TSP=0.00022(A)^{1.5}}\ kg/blast$$

Where:

E =Emission rate (kg/blast)

A = Blast mine area (m^2)

The emissions factor for particulate matter with aerodynamic diameter 10 µm and 2.5 µm were obtained by multiplying the resultant TSP value by 0.52 and 0.03 respectively. The emission factor relates the amount of particulate matter emitted (in kg) to the surface area that is blasted. As per Client data, an area of approximately 4 000 m^2 will be blasted, with 1 blast per day. A factor of 3% was applied to the TSP equation to determine the resultant PM2.5 emission rate (USEPA, 2006). Control efficiencies of 50% for TSP and 5% for both PM10 and PM2.5 were applied for pit retention (NPI, 2012). The calculated emission rates for blasting is given in Table 6.2 for a 12-hour operation.

E_{TSP} ={ [0.00022*$(4000)^{1.5}$*1000]/(12*3600)}*0.5 =6.44E-01

E_{PM10}= {[(0.00022*0.52)$(4000)^{1.5}$*1000/(12*3600)]} =6.67E-01

$E_{PM2.5}$ =ER_{PM10} *0.03 =2.00E-02

Table 8-5: Emission rate due to blasting

Source	Emission Rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Blasting	6.44E-01	6.67E-01	2.00E-02

Gold Ore Crushing Emission

Crushers are used to reduce the size of the ore for ease of processing. In most cases this is a significant source of fugitive dust with large quantities of respirable fractions of dust released into the ambient atmosphere. Any ore with moisture greater than 4% by weight, either naturally or by virtue of added water, is considered as a “high moisture” ore. If an ore is “high moisture” at the primary crusher, then it will remain so unless it is dried in the process. Emissions from a primary crushing activity include emissions from the screens, the crusher and the surge bin that are integral to the crusher.

The following default emission factors for primary crushing (high moisture ore) were used to calculate particulate emissions respectively (NPI, 2012):

$$E_{TSP} = \frac{0.01kg}{tonne}$$

$$E_{PM10} = \frac{0.004kg}{tonne}$$

PM2.5 emissions were assumed to equal 30% of TSP (USEPA, 2006 particle size distribution for crushing) in the absence of a PM2.5 emission factor. A 50% control efficiency (NPI, 2012) was applied for the use of water sprays, as per Client data. Importantly, crushing emission factors include emissions from the screens, the crusher, feeder, and conveyor belt transfer points that are integral to the crusher (NPI, 2012). Furthermore, milling has been excluded as this is considered a wet process, and thus generates negligible dust levels. Physical parameters and calculated emission rates for crushing are given in Table 5.3 for throughput 303tonnes/hr.

Table 8-6: Emission rate for crushing

Source	Emission Rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Primary Crushing	4.21E-01	1.68E-01	5.05E-02

Material Handling

Materials handling operations predicted to result in fugitive emissions include the transfer of material by means of tipping, loading and offloading. The quantity of dust which will be generated from such loading and off-loading operations will depend on various climatic parameters, such as wind speed and precipitation, in addition to non-climatic parameters such as the nature (moisture content) and volume of the material handled. Fine particulates are more readily disaggregated and released to the atmosphere during the material transfer process as a result of exposure to strong winds. Increase in the moisture content of the material being transferred would decrease the potential for dust emissions since moisture promotes the aggregation and cementation of fines to the surfaces of larger particles (USEPA, 2006).

The following default emission factors were used to calculate particulate emissions respectively (NPI, 2012):

E_{TSP} = 0.005 kg/$tonne$

E_{PM10} = 0.002 kg/$tonne$

$PM_{2.5}$ emissions were assumed to equal 5.3% of TSP (USEPA, 2006) in the absence of a $PM_{2.5}$ emission factor. A control efficiency of 50% (NPI, 2012) for water sprays, as per Client data, was applied to the materials handling activities. Importantly, material handling from crushing activities (transfer of material) are excluded (to prevent double accounting of emissions) as the crushing emission factors include emissions from the screens, the crusher, feeder, and conveyor belt transfer points that are integral to the crusher (NPI, 2012). Physical parameters and calculated emission rates for materials handling are given in table 5.4 and 5.5 for 24-hour operation, 7 days a week.

Table 8-7: Source parameters for material handling activities

Source	Control Efficiency (%)	Total Throughput (ton/hr)
Main Pit		
Removal of overburden waste	50%	2118
Offloading onto haulage truck	50%	2118
Offloading from haulage truck onto WRD	50%	2118
Removal of ore	50%	412

Offloading of ore onto haulage truck	50%	412
Offloading from haulage truck to ROM pad	50%	412
Ore Processing		
Loading ore from ROM pad into primary crusher	50%	303
Material tipped onto mill from stockpile	50%	266
Quick time conveyed to mill	50%	0.54

Table 8-8: Emission rate for material handling activities

Source	Emission Rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Main Pit			
Removal of overburden waste	1.47E+00	5.88E-01	7.79E-02
Offloading onto haulage truck	1.47E+00	5.88E-01	7.79E-02
Offloading from haulage truck onto WRD	1.47E+00	5.88E-01	7.79E-02
Removal of ore	2.86E-01	1.14E-01	1.52E-02
Offloading of ore onto haulage truck	2.86E-01	1.14E-01	1.52E-02
Offloading from haulage truck to ROM pad	2.86E-01	1.14E-01	1.52E-02
Ore Processing			
Loading ore from ROM pad into primary crusher	2.10E-01	8.42E-02	1.12E-02
Material tipped onto mill from stockpile	1.85E-01	7.39E-02	9.79E-03
QuickTime conveyed to mill	3.72E-04	1.49E-04	1.97E-05

Vehicle entrainment on unpaved roads

Re-suspended particulate emissions from unpaved roads originate from, and result in the depletion of, the loose material on the road surface (i.e. the surface loading). In turn, that surface loading is continually replenished by other sources. Surface loading is replenished by the spillage of material and trackout from unpaved roads and staging areas. The emission factor for particulate emissions generated by wheel entrainment on unpaved roads is estimated using the following equations:

$$E_{PM10} = [1.5\left(\frac{s}{12}\right)^{0.9}(\frac{W}{3})^{0.45}](281.9)g/VKT$$

$$E_{PM\ .5} = \left[0.15\left(\frac{s}{12}\right)^{0.9}\left(\frac{W}{3}\right)^{0.45}\right](281.9)g/VKT$$

Where:

E = Size specific emission factor (g/VKT)

S= surface material silt content (%)

W = mean vehicle weight

The road surface silt content of 10.2% for unpaved roads was used, in the absence of specific gold mining silt content for the TKGP. A control efficiency of 75% (NPI, 2012) was applied for wet suppression, as per Client data, along unpaved roads. Additionally, haul trucks operate 24-hours/day, 7 days a week. Table5.6 and Table 6.7 provide the source parameters and emission rates for unpaved haul roads at the TKGP.

Table 8-9: Source parameters for unpaved roads

Source	Length (m)	Width (m)	Mean vehicle weight (ton)	VKT/day	Control efficiency (%)
Main haul road- ore from mine to ROM pad	1000	24	90	674	75
Keley to Tulu Kapi access road	14200	6	10	28	75

Table 8-10: Emission rates for wheel entertainment on unpaved roads

Source	Emission rate (g/s/m^2)		
	TSP	PM_{10}	$PM_{2.5}$
Main haul road- ore from mine to ROM pad	4.63E-04	1.37E-04	1.37E-05
Keley to Tulu Kapi access road	1.47E-06	4.34E-07	6.06E-08

<u>Wind Erosion from exposed surfaces</u>

Significant emissions can arise due to the mechanical disturbance of granular material from open areas and storage piles. Parameters which have the potential to impact on the rate of emission of fugitive dust include the extent of surface compaction, moisture content, ground cover, the shape of the storage pile, particle size distribution, wind speed and precipitation. Any factor that binds the erodible material, or otherwise reduces the availability of erodible material on the surface, decreases the erosion potential of the fugitive source. High moisture content, whether due to precipitation or deliberate wetting, promotes the aggregation and cementation of fines to the surfaces of larger particles, thus decreasing the potential for dust emissions. Surface compaction and ground cover similarly reduces the potential for dust generation. The shape of a storage pile influences the potential for dust emissions through the alteration of the airflow field. The particle size distribution of the material on the disposal site is important since it determines the rate of entrainment from the surface, the nature of dispersion of the dust plume, and the rate of deposition.

Dust emissions due to the erosion of open storage piles and exposed areas occur when the threshold wind speed is exceeded (Cowherd et al., 1988; USEPA, 1995). The threshold wind speed is dependent on the erosion potential of the exposed surface, which is expressed in terms of the availability of erodible material per unit area (mass/area). Studies have shown that when the threshold wind speed is exceeded, erosion rates tend to increase rapidly (Cowherd et al., 1988).

The default particulate emission factors for wind erosion over open areas are calculated using the below equation (NPI, 2012):

$E_{TSP} = 0.4\ \text{kg}/ha/hour$

$E_{PM10} = 0.2\ \text{kg}/ha/hour$

$PM_{2.5}$ emissions were assumed to equal 15% of TSP (USEPA, 2006) in the absence of a $PM_{2.5}$ emission factor. A 50% control efficiency (NPI, 2012) for the use of wet suppression, as per Client data, was applied. Further, it must be noted that the 35% of the TSF is considered to be wet, as per Client data. Source parameters for areas subject to wind erosion are given in Table 6.8. Emission rates were applied to the various wind erosion activities and are presented in Table 14 for a 24-hour operation, 7 days a week.

Table 8-11: Source Parameters subject to wind erosion

Source	Area(m^2)	Control Efficiency (%)
WRD west of the proposed main pit	445000	50
WRD Nort-East of the proposed main pit	530000	50
WRD South of the proposed main pit	990000	50
ROM pad	50000	50
TSF	170000	50

Table 8-12:Emission Rate for wind erosion

Source	Emission Rate (g/s/m^2)

	TSP	PM_{10}	$PM_{2.5}$
WRD west of the proposed main pit	5.56E-06	2.78E-06	4.17E-07
WRD Nort-East of the proposed main pit	5.56E-06	2.78E-06	4.17E-07
WRD South of the proposed main pit	5.56E-06	2.78E-06	4.17E-07
ROM pad	5.56E-06	2.78E-06	4.17E-07
TSF	3.61E-06	1.17E-06	2.71E-07

8.1.4. Summary of Estimated Emissions

A summary of emissions from different sources were summarized in table 9.

Table 8-13: summary of estimated emissions from TKGP

Source	Emission Rates		
	TMP	PM_{10}	$PM_{2.5}$
Construction Phase			
Operational Phase			
Drilling	3.48E-01	1.81E-01	1.04E-02
Blasting	6.44E-01	6.67E-01	2.00E-02
Crushing	4.21E-01	1.68E-01	5.05E-02
Material Handling	5.66E+00	2.26E+00	3.00E-01
Vehicle Entrainment from unpaved roads	1.12E+01	3.32E+00	3.34E-01
Wind erosion	1.18E+01	5.80E+00	5.80E+00
Operational phase sum	**3.01E+01**	**1.24E+01**	**6.52E+00**

Fugitive emissions from the TKGP have the potential to arise from the following sources:

- Materials handling activities
- Wind erosion from stockpiles
- Vehicle entrainment from unpaved roads
- Drilling
- Blasting
- Gold Ore Processing Plant activities (crushing)

Importantly, the operational data for the worst-case scenario (year 2023) was used to determine the air quality impacts from the TKGP as a conservative approach.

Furthermore, the cumulative impacts (i.e. measured background concentrations added to the predicted modelling contributions from the proposed TKGP) have not been determined to assess compliance with the relevant guidelines as the background monitoring concentrations are considered outdated (older than five years to date), and are further not considered reliable seeing that various changes could have resulted in the air quality region over the past few years. This will need to be updated, once more recent data becomes available.

8.1.5. **Atmospheric Dispersion Modelling**

Air quality models use mathematical and numerical techniques to simulate the physical and chemical processes that affect air pollutants as they disperse and react in the atmosphere. Based on inputs of meteorological data and source information like emission rates and stack height, these models are designed to characterize primary pollutants that are emitted directly into the atmosphere and, in some cases, secondary pollutants that are formed as a result of complex chemical reactions within the atmosphere.

AERMOD is a steady-state plume model. In the stable boundary layer (SBL), it assumes the concentration distribution to be Gaussian in both the vertical and horizontal. In the convective boundary layer (CBL), the horizontal distribution is also assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function (pdf). in the CBL, AERMOD treats “plume lofting,” whereby a portion of plume mass, released from a buoyant source, rises to and remains near the top of the boundary layer before becoming mixed into the CBL. AERMOD also tracks any plume mass that penetrates into the elevated stable layer, and then allows it to re-enter the boundary layer when and if appropriate. For sources in both the CBL and the SBL AERMOD treats the enhancement of lateral dispersion resulting from plume meander. Centration’s result from small changes in input parameters.

AERMOD can simultaneously simulate many sources with different shapes, at ground or elevated, buoyant or non-buoyant, emitting one or more pollutants. AERMOD is capable to account for the non-homogeneous vertical structure of the boundary layer (also through the use of a vertical profile of meteorological variables). Vertical mixing is limited in case of stable conditions. The dispersion for unstable conditions is non-Gaussian, so to correctly describe the high concentrations of pollutants that can be observed close to stacks under convective conditions.

AERMOD is made of different modules:

- The atmospheric dispersion module (itself called AERMOD).
- The terrain processor AERMAP, which is used in presence of complex terrain to evaluate the scale height of each receptor.
- The meteorological processor AERMET, which is used to prepare the input for the simulations with the dispersion module.
- The AERSURFACE module can be used to determine the geophysical parameters (roughness length, albedo, Bowen ratio) to be inputted in AERMET.

AERMOD requires two sets of meteorological data, one at surface and the other referring to a vertical profile, both with hourly time resolution. The required variables at surface are: sensible heat flux, friction velocity, convective velocity, vertical temperature gradient in the first 500 m above the planetary boundary layer, the extent of the convective boundary layer, the extent of the mechanical boundary layer, the Monin Obukhov length, the surface roughness, the Bowen ratio, the albedo, the wind speed, the wind direction, the anemometer height, the temperature, the thermometer height. Variables included in the vertical profile are, for each elevation above ground, the elevation itself, the wind speed, the wind direction, the temperature, the standard deviation of wind direction and the standard deviation of vertical wind speed.

Model Input

Geophysical data requirements include land use type and terrain elevation. Land use categories and terrain of the surrounding region are defined when processing AERMET and AERMAP respectively. Often, the in-built land use classification type and the terrain heights derived from the 90m SRTM DEM product are employed. The aforementioned parameters exact strong influence on wind speed and turbulence, which are key components for dispersion. AERMOD model system and for this study include: emissions source data, meteorological data and information on the nature of the receptor grid. Parameters required depend on the source type (point, line, area or volume).

Meteorological data is crucial as this principal factor to the dispersion of pollutants in the atmosphere i.e. vertical profiles of wind speed and direction, atmospheric turbulence and ambient air temperature. It is worth mentioning that topography plays a significant role in dispersion of emissions from source. Topographic features create mechanical drag, inducing turbulence and the subsequent dispersion of pollutants and atmospheric mixing / dilution. . Data input into the model includes modelled MM5 surface and upper air meteorological data with wind speed, wind direction, temperature, pressure, precipitation, cloud cover and ceiling height from January 2020 to December 2022.

Terrain data at a resolution of 90 m (SRTM3) was also input into the model. A modelling domain of 30 km × 30 km was used , with multi-tier Cartesian grid receptor spacing's of 50 (1 km from source), 100 (5 km from source), 250 m (10 km from source) and 1 000 m (30 km from source). A receptor spacing of 50 m was also located along the boundary of the TKGM operations.

Table 8-14: Modelling domain coordinates

Domain Point	UTM East (m)	UTM South (m)
North-eastern Point	811153.51	1034608.76
South-western Point	751160.88	974502.08

Model Settings

Table 8-15: lists the model settings used for TKGP AERMOD prediction.

Table 8-15: Model Settings summary

Parameters	Setting
Dispersion Model	AERMOD VIEW 11.2.00
Supporting Models	AERMET and AERMAP

Pollutants modelled	Dust fallout, PM10 and PM2.5
Flag Pole Height	1.5 m
Sectors	Cultivated land
Terrain Settings (simple, flat, elevated)	Flat and slightly elevated
Terrain Data	SRTM3
Terrain Data Resolution (m)	90
Elevation Data	The WebGIS Shuttle Radar Topography Mission (STRM) Terrain data was used with a resolution of 90 m
Bowen Ratio	0.75, 0.925
Surface Albedo	0.28, 0.29
Surface Roughness	0.0725, 0.04025
Number of Sectors	2
Modelling Domain Centre (UTM)	781224.00 m E, 1004590.00m N
Modelling Domain (km)	30 x 30
Property Line Resolution (m)	50
Fine Grid Resolution (m)	50
Medium Grid Resolution (m)	100, 250 and 1000

Modelling Scenario

The operational phase of TKGP was modelled under is the worst-case scenario. All relevant averaging periods were modelled for pollutants of concern. In all instances the worst-case scenario has been presented to demonstrate the highest predicted impact. It is important to note that highest period-averages (i.e. highest hourly average and highest 24- hour-average) presented in the maps are indicative of the highest expected concentrations for the period-average for the modelled year at each position in the modelled domain, and must not be interpreted as being representative of general conditions. The intent of the maps is to conservatively present the worst-case scenario for those averaging periods.

The ground level concentrations closely follow the main wind directions (wind roses generated for the site). Numerical values of maximum depend on the emission rate and the prevailing meteorological condition of the area. Simulations were undertaken to determine concentrations of particulate matter with a particle size of less than 10 µm in size (PM10), particle size of less than 2.5 µm in size (PM2.5) and for dust deposition (≥ 30 µm). These simulations were undertaken to determine concentrations without mitigation.

Isopleth plots of predicted concentrations of pollutants: PM10, PM2.5, and dust deposition rates for the worst-case scenario (where mitigation measures are not applied for topsoil, overburden dumps and activities like tipping and haulage) were predicted for the respective averaging periods).

Isopleth plots and modelling results

The dispersion model predictions presented in this section include those for the operation of TKGP Project in isolation (incremental impact) for total dust (TSP), PM_{10} and $PM_{2.5}$. It is important to note that when assessing impacts per the maximum 24-hour average levels, these predictions are based on the highest predicted 24-hour average concentrations that were modelled at each point within the modelling domain for the worst day (i.e. a 24-hour period) in the one year long modelling period. The predictions do not represent just one particular day, but a combination of days and is an overestimation of what would actually occur.

Concentration results at specified sensitive receptors are presented in tabular format, while concentration isopleths are presented graphically to indicate the dispersion of pollutants. Comparison of the predicted concentrations was made with the relevant international ambient air quality guidelines to determine compliance.

Dust Deposition Predicted Impacts

The predicted dust deposition rates anticipated from the proposed operation show that dust levels will not be a course for concern. The predicted maximum concentration at the mine boundary is lower than the 600 mg/m2/day recommended standard. Exposure will be higher within the mine boundary (Figure 7.1). All sensitive receptors will not be affected by dust deposition (Table 7.3). Major contributions are coming from the use of haul roads and from wind erosion of stockpiles respectively.

PM10 Predicted Impacts

The predicted highest 24-hour (daily) concentration of PM10 attributed to the proposed TKGP Mine is presented in Figure 7.2. The highest concentration predicted at the project boundary, in most location is well below the current IFC guideline limit of 50 µg/m³. Only 3 sensitive receptors fall a little over the guideline limit (Table 7.3). The major contributors are dirt roads and wind erosion.

The predicted concentrations are the likely additions that can be anticipated from the proposed TKGP Mine on ambient air quality and not cumulative impact from all the existing sources in the area. It is therefore possible that the highest daily concentration predicted to occur at a certain location may only be true for one day during the entire period. Once mitigation measures were applied, exceedances were limited to the project area.

PM2.5 Predicted Impacts

The predicted highest 24-hour (daily) concentration for PM2.5 at the proposed TKGP Mine is presented in Figure 7.4. This isopleth plot of predicted maximum daily values for $PM_{2.5}$ from all sources without mitigation measures is in exceedance of the standard (65 µg/m³) within the project boundary. The predicted PM2.5 concentrations at the mine boundary were mainly in the range 25 µg/m³ - 60 µg/m³. The zones of impact were minimized once mitigation measures were applied.

Fig 7.6, Fig 7.7 and Fig 7.8 illustrate annual dust, PM_{10} and $PM_{2.5}$ predicted deposition due to TKGP and overall the impacts to surrounding community is minimal.

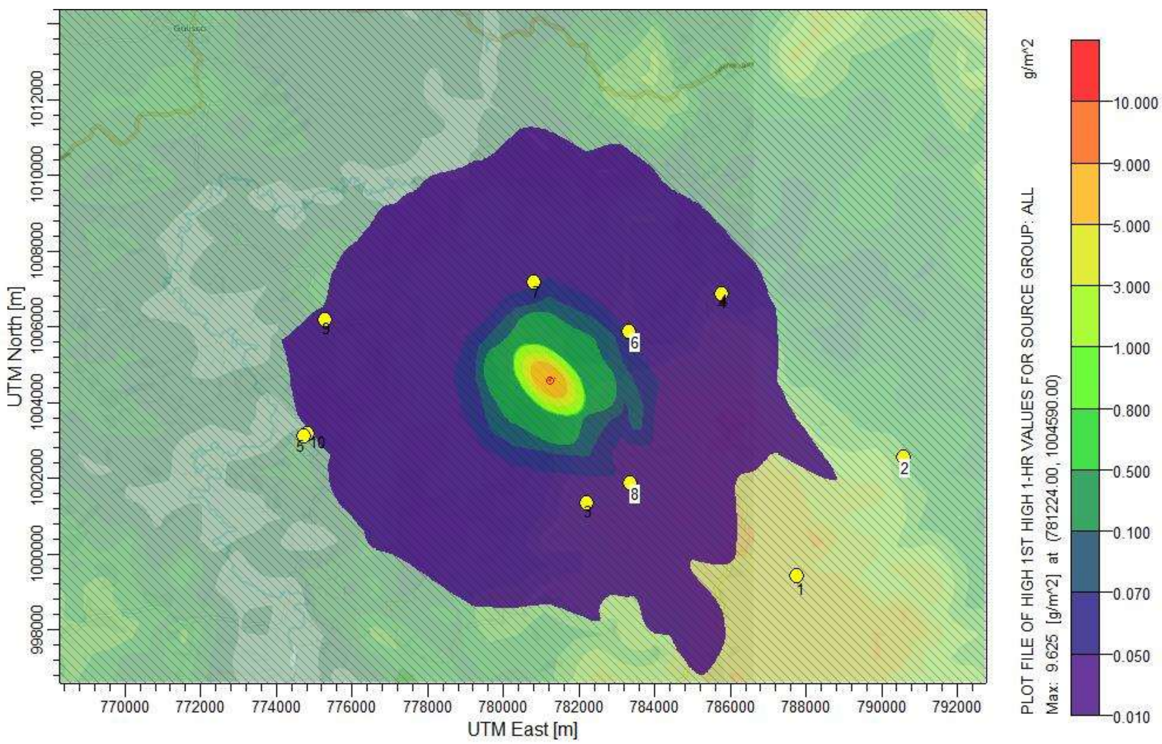

Figure 8.2: TKGP model Predicted 24-Hour Concentration of TSP

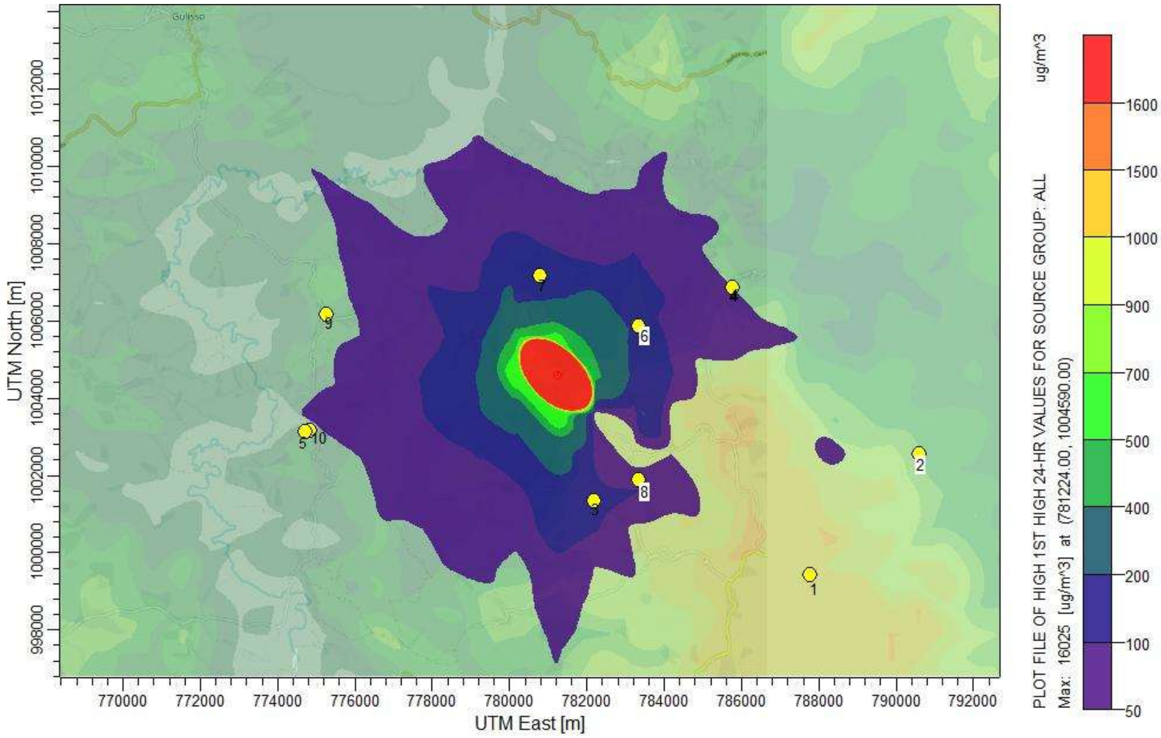

Figure 8.3:TKGP model Predicted 24-Hour Concentration of PM 10

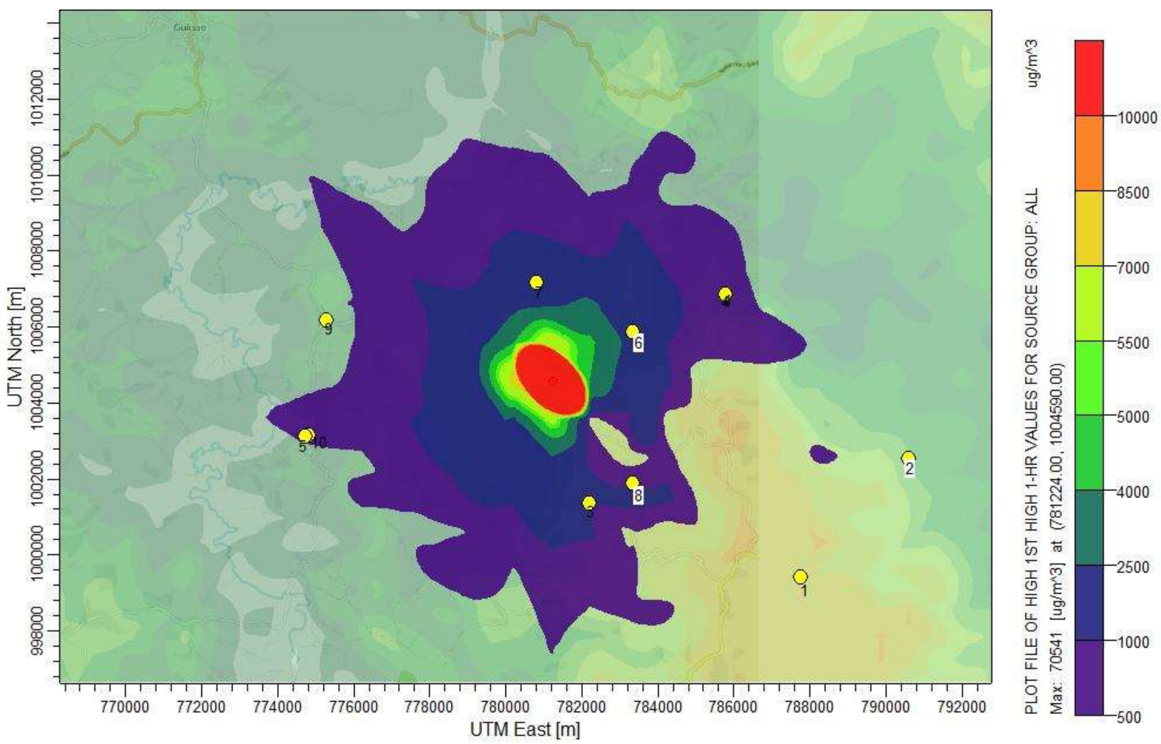

Figure 8.3:PM10 1 -Hour Concentration

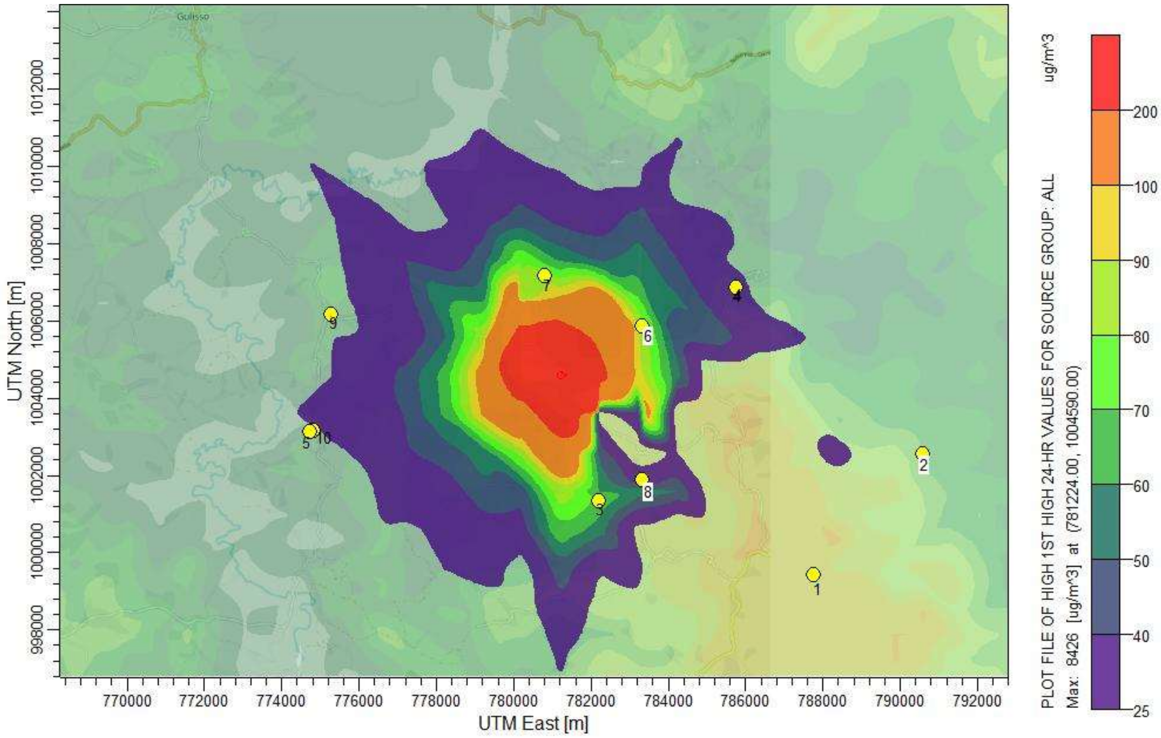

Figure 8.3: TKGP model Predicted 24-Hour Concentration of PM 2.5

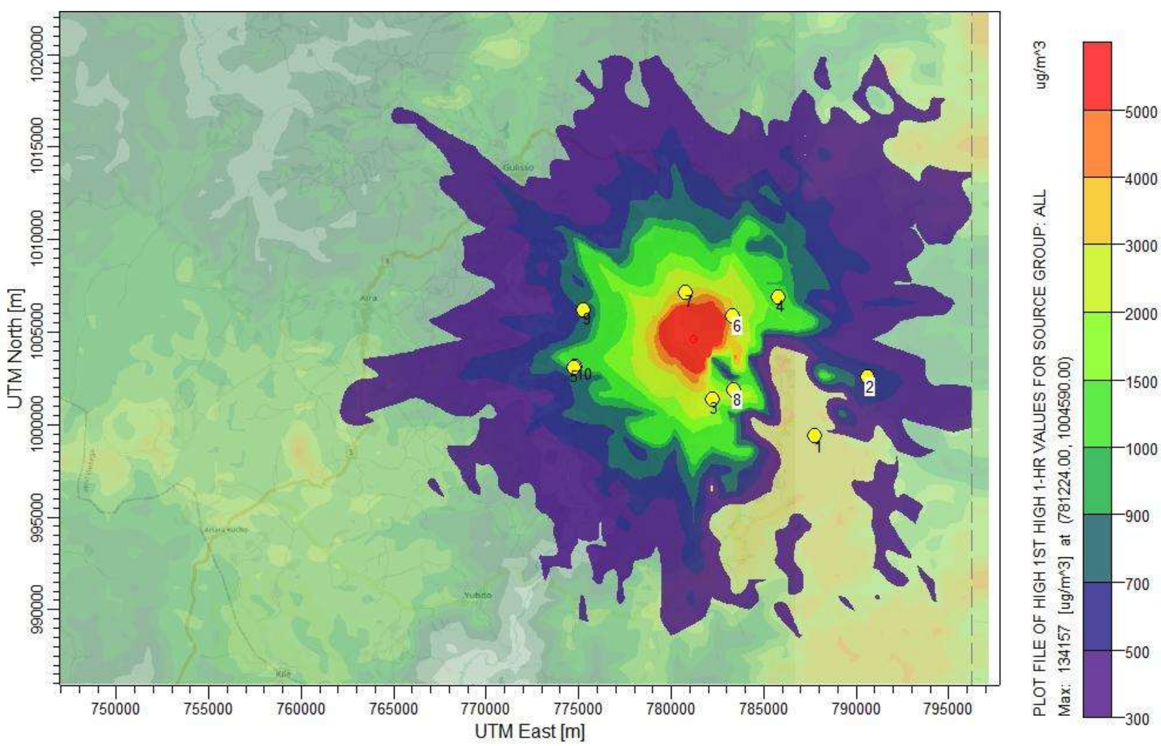

Figure 8.3: PM2.5 1-Hour Concentration

Table 8-16: TKGP Sensitive Receptors Summary

Averaging Period	Rank	Receptor ID	X (m)	Y (m)	Elevation (m)	Peak Dust (g/m^2)	Peak PM10 (ug/m^3)	Peak PM2.5 (ug/m^3)
24-HR	1ST	1	787757.00	999430.00	1809.65	0.01367	6.73857	12.81569
24-HR	1ST	2	790584.00	1002557.00	1626.22	0.00565	14.55771	27.68643
24-HR	1ST	3	782189.00	1001358.00	1711.14	0.04122	69.31115	131.81876
24-HR	1ST	4	785759.00	1006870.00	1630.14	0.02348	26.53333	50.46216
24-HR	1ST	5	774820.00	1003167.00	1501.96	0.01365	23.79752	45.25908
24-HR	1ST	6	783324.00	1005876.00	1705.39	0.11400	86.73729	164.96050
24-HR	1ST	7	780787.00	1007174.00	1665.04	0.10312	83.87248	159.51208
24-HR	1ST	8	783330.00	1001884.00	1755.65	0.05451	31.69331	60.27561
24-HR	1ST	9	775265.00	1006188.00	1612.04	0.02284	16.41212	31.21323
24-HR	1ST	10	774709.00	1003124.00	1514.25	0.01407	23.22141	44.16341

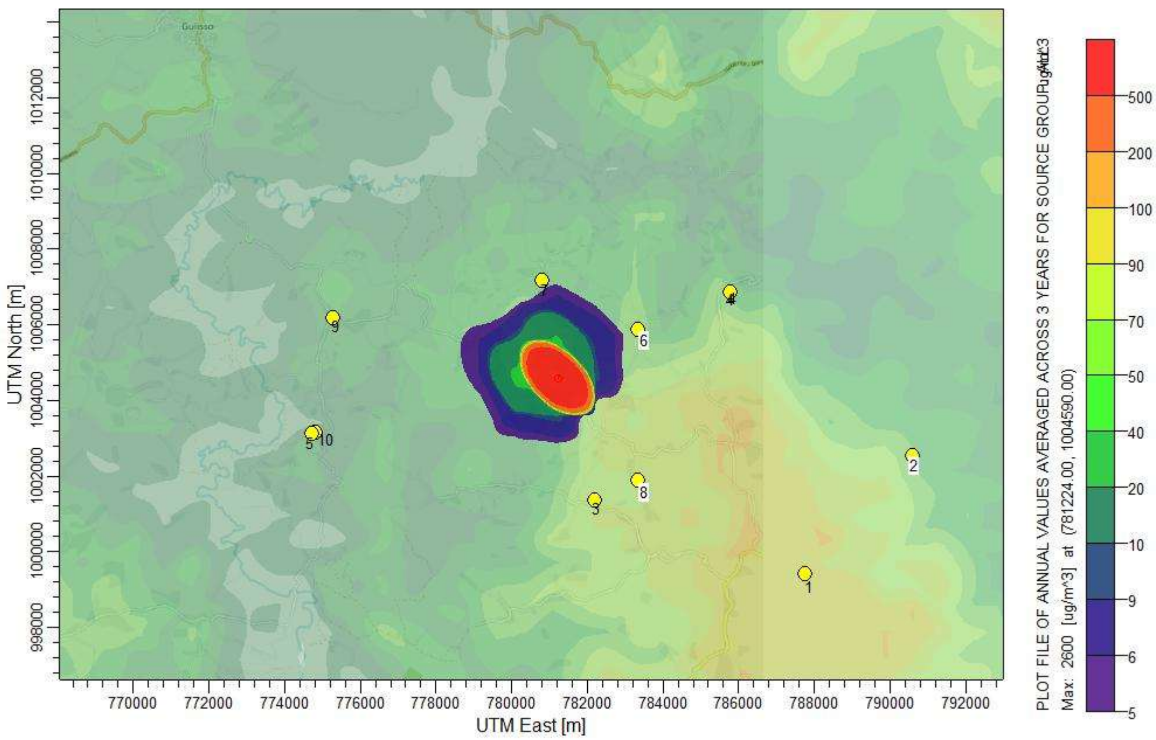

Figure 8.4: Annual Predicted Dust Deposition

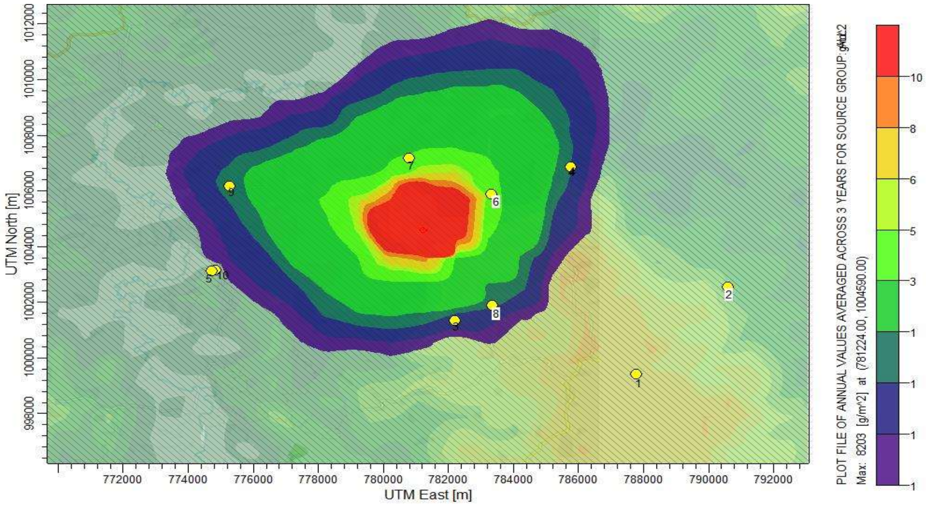

Figure 8.5: Annual Predicted PM10

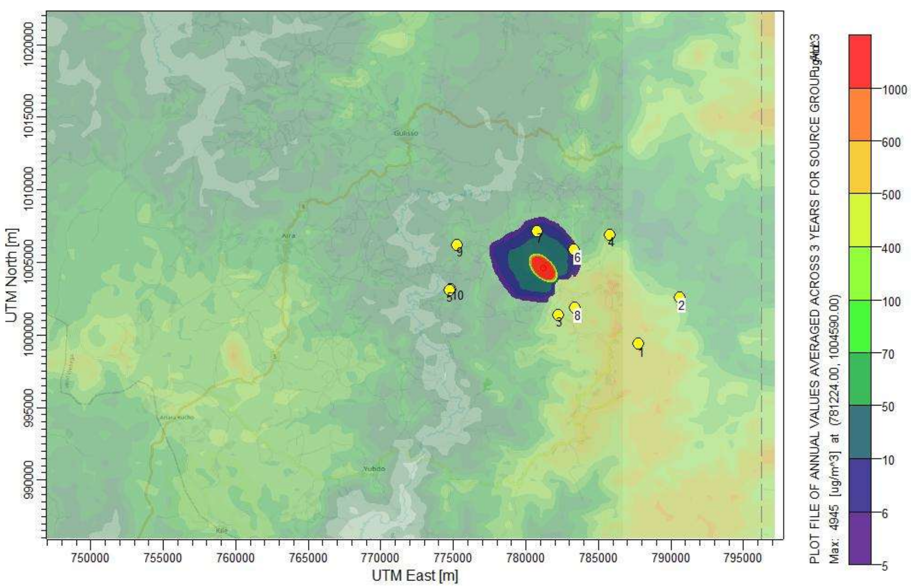

Figure 8.6: Annual Predicted PM2.5

8.1.6. Recommended Mitigation

The dispersion modelling simulations show that particulate concentrations are a concern. Suitable mitigation measures must therefore me implemented throughout the mining operations with a special focus on the processing plant, unpaved roads, and open pit.

Reduction of vehicle emissions will be ensured by regularly scheduled maintenance of vehicles, use of appropriate high-quality fuels and lubricants, and minimization of vehicular traffic to, from and on site whenever practical. Vehicle engines will be switched off when not in use. Dust reduction measures will include strictly enforced vehicle speed limits, dampening of loading and unloading points and exposed surfaces; stabilizing and re vegetation of bare soils wherever appropriate; and secure covering of aggregate loads during transport. An appropriate network of roads will be maintained for community use after closure as identified in consultation with communities and all non-required mine roads and disturbed areas will be rehabilitated.

Note: Any sensitive receptors, if left within the mining boundary will experience exceptionally high levels of TSP concentrations. It is recommended that all receptors be relocated to the south-east outside the boundary.

8.2. Climate Change

This section reviewed and updated the Climate Change and Greenhouse Gas Emissions Assessment report by Golder Associates Africa ltd (Golder 2020) and provides an overview of sources and receptors considered in the assessment Along with an outline of the methods used to evaluate project-related air emissions Followed by an evaluation of the impacts.

8.2.1. Overview of Sources and Receptors

8.2.1.1. Sources

GHG emissions are classified into three 'scopes':

- Scope 1: direct GHG emissions occurring from sources owned or controlled by the company.
- Scope 2: indirect GHG emissions occurring from the generation of purchased electricity.
- Scope 3: other indirect GHG emissions occurring because of company activities but occur from sources not owned or controlled by the company (such as staff transport, emissions from air travel).

The main sources of Scope 1 and Scope 2 emissions of greenhouse gases (carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, hydro fluorocarbons, and per fluorocarbons) from the project are associated with:

- Fuel combustion in stationary equipment.
- Fuel combustion in mobile project equipment and vehicles.
- Generation of electricity from the on-site diesel generators (used during construction and retained as back-up for the operation phase.
- Generation of purchased electricity from national grid.
- Land clearance activities (removal of CO_2 sinks).

For the purposes of this assessment, only the main Scope 1 and 2 sources of greenhouse gases have been incorporated. The minor sources of Scope 1 and 2 emissions are not incorporated as these are unlikely to be material in the context of the overall greenhouse gas inventory; however, this will be evaluated as part of a site inventory during operations. Scope 3 emissions are also excluded.

The total GHG emissions during the construction phase is estimated to be 16 916 tCO2e, with an average of 8 458 tCO2e per annum. During the operational phase, it is estimated that the total GHG emissions will be 270 368 tCO2e, with an average of 33 796 tCO2e per annum. The total GHG emissions during the closure phase is estimated to be 8 004 tCO2e (Golder 2020).

In an ESIA, the potential impact of a project is typically assessed using the methodology used for the climate change assessment component of this report (see Section 4.1). However, given that the contribution of the TKGP to global GHG emissions is relatively insignificant, and the extended period between the emission of GHGs and potential climate change impacts, the conventional approach to impact assessment may not be appropriate. As a result, GHG emissions assessments typically use an alternative approach to impact assessment based on benchmarks. In the context of this assessment, three benchmarks are considered:

- Contribution of the Project's GHG emissions to Ethiopia's national GHG emissions
- Product unit intensity
- Pre-defined thresholds

These benchmarks have been used to assess the significance of the Project's GHG emissions (Golder 2020).

8.2.2. Receptors

The impact of increased emissions of GHG cannot be evaluated on a project scale basis since the effects are global in nature and at this scale the magnitude of impact from a project like Tula Kapi is indistinguishable.

8.2.3. Potential Impacts

8.2.3.1. Contribution to Ethiopia's National GHG Emissions

As discussed previously, Ethiopia's total GHG emissions were 141.1 MtCO2e in 2011, with an average increase of 3% per annum between 1993 and 2011.

In the business-as-usual scenario (without mitigation), Ethiopia's total GHG emissions are predicted to increase to 400 MtCO2e by 2030. For the purposes of this assessment, it is assumed that annual GHG emissions increase by 5.7% year-on-year. Ethiopia has however committed in its INDC to reducing its emissions by 64% from the business-as-usual scenario of 400 MtCO2e to 145 MtCO2e by 2030. For the purposes of this assessment, it is assumed that Ethiopia reduces its year-on-year increase in GHG emissions to 0.14% in order to meet its INDC commitments.

Table 84 presents the estimated contribution of the Project's GHG emissions to Ethiopia's total GHG emissions of Ethiopia in the business-as-usual scenario (without mitigation) and with the successful implementation of the INDC commitments (with mitigation). Graduated colours are used to highlight years where the Project makes the greatest contribution (shown in red) and lowest contribution (shown in green) to Ethiopia's total GHG emissions.

In the business-as-usual scenario, the GHG emissions from the Project will initially start with a 0.001% contribution, peaking in 2024 with 0.024% contribution, and decreasing year-on-year thereafter. In the scenario where Ethiopia has successfully met its INDC commitments, the GHG emissions from the TKGP will initially start with a 0.001% contribution, peaking in 2024 with 0.03% contribution, and decreasing year-on-year thereafter. Given that the TKGP will contribute a maximum of 0.03% to Ethiopia's annual GHG emissions over the 11-life of the Project, the significance of the impact is rated as low as the contribution is negligible.

Table 8-17: Contribution of the TKGP to Ethiopia's annual GHG emissions with and without mitigation

Year	TKGP's GHG emissions (tCO2e)	Ethiopia's GHG emissions without mitigation (tCO2e)	% of Ethiopia's GHG emissions without mitigation	Ethiopia's GHG emissions with mitigation (tCO2e)	% of Ethiopia's GHG emissions with mitigation
2021	2 098	277 363 158	0.001%	143 152 632	0.001%
2022	14 818	290 989 474	0.005%	143 357 895	0.010%
2023	42 377	304 615 789	0.014%	143 563 158	0.030%
2024	40 852	318 242 105	0.013%	143 768 421	0.028%
2025	44 623	331 868 421	0.013%	143 973 684	0.031%
2026	44 970	345 494 737	0.013%	144 178 947	0.031%
2027	42 605	359 121 053	0.012%	144 384 211	0.030%
2028	31 050	372 747 368	0.008%	144 589 474	0.021%
2029	19 814	386 373 684	0.005%	144 794 737	0.014%
2030	4 077	400 000 000	0.001%	145 000 000	0.003%
2031	8 004	413 626 316	0.002%	145 205 263	0.006%

8.2.3.2. Product Unit Intensity

Benchmarking potential GHG emissions resulting from the TKGP against emitters in the same sector can also be used to assess the significance of a Project's GHG emissions. To allow for comparison, the average emissions intensity per product unit (i.e. CO2e per product unit) is typically used. Given that the product unit of the TKGP is ounces of gold, the emissions intensity per product unit is tCO2e/oz.

Table 85 presents the GHG emissions intensity of the TKGP based on annual production and total Scope 1 and 2 GHG emissions. On average, the product unity intensity of the TKGP will be 0.29 tCO2e/oz, ranging between 0.15 tCO2e/oz in 2030 and 0.38 tCO2e/oz in 2025.

Table 8-18: Product unit intensity of the TKGP

Year	GHG emissions (tCO_2e)	Gold production (oz)	GHG intensity (tCO_2e/oz)
2023	42 377	156 000	0.27
2024	40 852	141 000	0.29
2025	44 623	116 000	0.38
2026	44 970	147 000	0.31
2027	42 605	118 000	0.36
2028	31 050	118 000	0.26
2029	19 814	115 000	0.17
2030	4 077	27 000	0.15
Total	**270 368**	**938 000**	**0.29**

Tost *et al*. (2018) undertook a review of scientific literature and company data from mining companies around the world to determine the environmental impact of mining in terms of CO_2 emissions, water consumption, and land use. A number of major gold mining companies were included in the study, namely Barrick, Newmont, Anglo Gold Ashanti, Goldcorp and Kinross. This study found that CO_2 emissions from gold mining ranges from a minimum of 0.50 tCO_2e/oz to a maximum of 0.85 tCO_2e/oz, with an average 0.66 tCO_2e/oz. At 0.29 tCO_2e/oz, the average product unit intensity of the TKGP is below the minimum product unit intensity of the study (0.50 tCO_2e/oz).

8.2.3.3. Pre-Defined Thresholds

The EBRD developed thresholds which can be used for benchmarking the magnitude of annual emissions of a project (Table 8-19).

Table 8-19: Benchmark thresholds for annual CO_2e emissions (EBRD, 2010)

GHG emissions (tCO_2e/a)	Qualitative rating
< 10,000	Nominal/Negligible
10,001 – 25,000	Low
25,001 – 100,000	Medium-Low
100,001 – 1,000,000	Medium-High
> 1,000,000,001	High

The annual GHG emissions from the TKGP is estimated to be 26 844 tCO_2e. The Project therefore falls within the 25 001 – 1 00 000 tCO_2e threshold and the impact is therefore rated as medium-low.

8.2.3.4. Summary

Table 8-10 presents a summary of the potential impacts of the TKGP in terms of the three benchmarks as detailed in the preceding sections. The overall impact of the TKGP, with respect to GHG emissions, is likely to be low.

Table 8 -20: Summary of potential GHG emissions impacts of the TKGP

Potential impact	Significance
Contribution to Ethiopia's national GHG emissions	Low
Product unit intensity	Low
Pre-defined thresholds	Medium - Low
Overall	**Low**

8.2.3.5. Recommended Mitigation

The proposed mitigation measures are as follows:

8.2.3.6. Construction Phase

- Install telemetry in all construction and fleet vehicles and monitor driver behaviour in terms of speeding, excessive braking, idling and so on. Investigate incidents of excessive consumption.

8.2.3.7. Operational Phase

- Install telemetry in all mining and fleet vehicles and monitor driver behaviour in terms of speeding, excessive braking, idling and so on. Investigate incidents of excessive consumption.
- Investigate technical and economic feasibility of using biofuel blend (up to 20% blend) in mining and fleet vehicles. Implement if found to be feasible and does not adversely affect warranty of vehicles (confirm with
- Suppliers).
- Investigate technical and economic feasibility of using diesel additives in mining and fleet vehicles. Implement if found to be feasible and does not adversely affect warranty of vehicles (confirm with
- Suppliers).
- Investigate technical and economic feasibility of installing expert mill control on the SAG mill to optimise control of the milling circuit, thereby increasing throughput while maintaining the required fineness of the
- Grind product. Thereby improving energy efficiency and reducing GHG emissions.
- Install high efficiency drives to reduce grid electricity consumption and GHG emissions. Where possible, fit variable speed drives to better match speed of drive with the load requirements.
- Where possible, install compressor units with high efficiency motors and integrated variable speed drives, thereby reducing grid electricity consumption and GHG emissions.
- Develop and implement an energy management system based on ISO 50001 methodology at the Ore Processing Plant to reduce energy consumption (and GHG emissions) from diesel and grid electricity
- Consumption.

8.2.3.8. Closure Phase

- Install telemetry in all demolition and fleet vehicles and monitor driver behaviour in terms of speeding, excessive braking, idling and so on. Investigate incidents of excessive consumption.

8.3. Noise and Vibration Impacts

The following section presents a summary of the Noise and Vibration Impact Assessment, which is attached as APPENDIX N.

8.3.1. Potential Impacts

8.3.1.1. Construction

The focus of the noise and ground vibration assessment is to determine changes to the existing ambient noise and ground vibration levels due to activities during the construction, operational and closure phases. The construction and closure phases will create a temporary increase in the prevailing ambient noise levels where it will become more permanent during the operational phase. This assessment focuses on potential effects as they relate to disturbance to people in noise sensitive areas along the mine boundary as all the noise sensitive areas within the mine boundaries will be relocated. The following activities will result in increased noise and ground vibration during construction Table 8-21.

- Construction of internal and external roads
- Preparation of the footprint area, earthworks and construction
- Transportation of material and equipment to the proposed mine
- Construction of the RWDs

Table 8-21: Noise intrusion levels during the construction phase

Vicinity of the mine activities	80 m	150 m	320 m	600 m	1 000 m	1 200 m
Open pit and plant - daytime	23.5dBA	17.5dBA	11.5dBA	2.5dBA	Becomes part of the ambient noise level	Becomes part of the ambient noise level
Open pit and plant – night time	29.5dBA	23.5dBA	17.5dBA	11.5dBA	5.5dBA	Becomes part of the ambient noise level

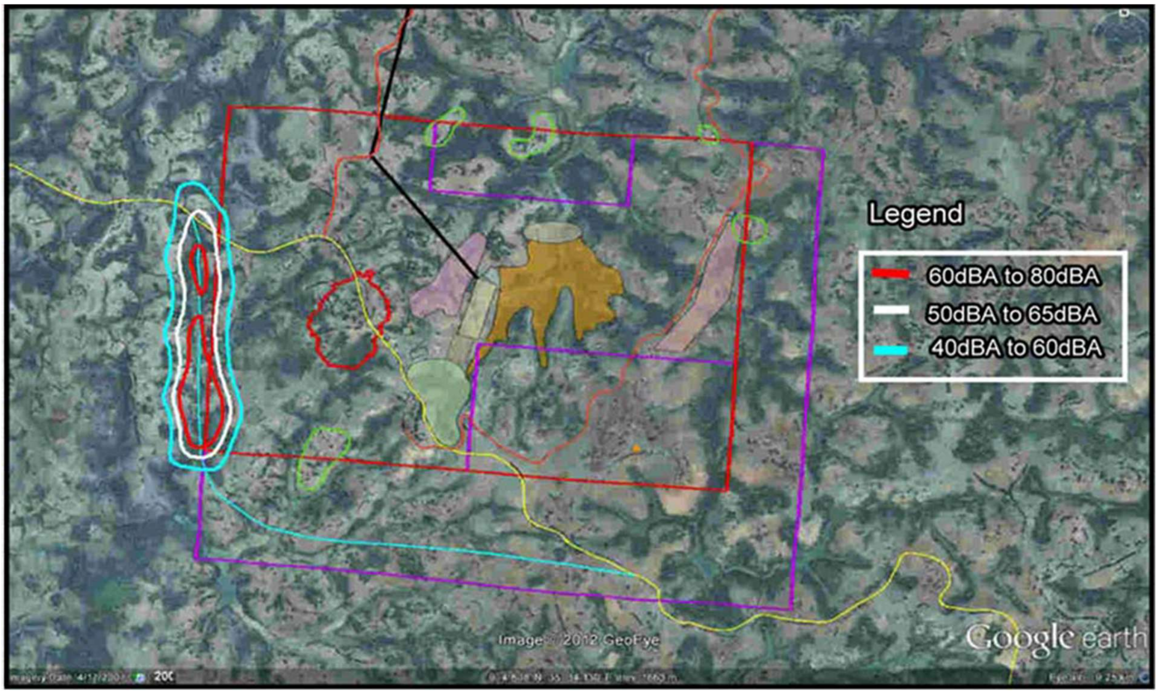

Figure 8.7: : Noise contour during the construction phase of the road (Note: Baseline data collection was conducted beginning in 2008; the project description has since been updated)

During road construction Figure 8-7, the noise increase will be site specific as construction activities take place in specific areas. This is a moveable point source as the road is constructed in sections.

8.3.1.2. Operation

In the operational phase, these activities will result in increased noise and ground vibration:

- Open pit mining
- Stockpile management
- Road maintenance
- Blast hole drilling in ore and waste
- Blasting
- Removal of ore from pit and hauling thereof
- Loading and off-loading ore and waste
- Crushing of ore
- Process plant activities

During the operational phase of the Project, blasting will take place three times a week during lunchtime. The noise increase is for a period of 3 seconds per blast only after which the prevailing ambient noise level will be maintained. A clearly defined blast zone has been included into the mine plan as of 500 m buffer surrounding the main pit.

With the north pit, blasting will only take place in the deeper parts. As there are households north of this pit that are outside of the mine license area, but within a distance of 200 m of pit, the impact of ground vibration and fly rock on these households will need to closely be monitored during the operational phase.

Figure 8-8 illustrates the noise increase and Figure 8-9 the sound pressure level increase during a blast at 900 m from the open pit.

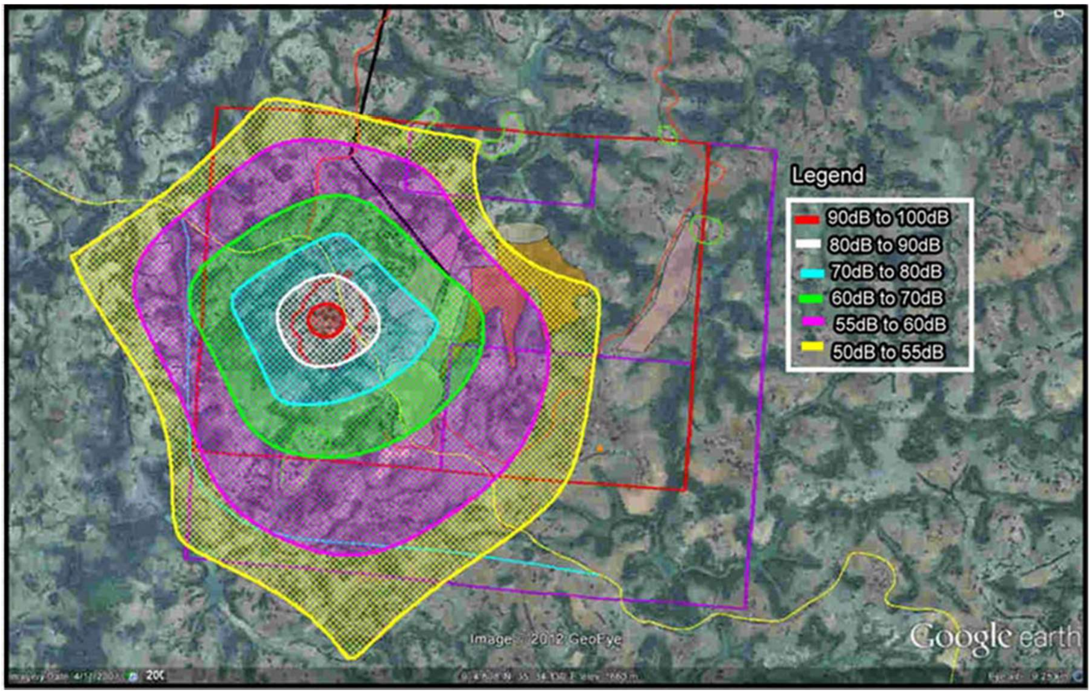

Figure 8-8: The noise contours during a blast at the open pit

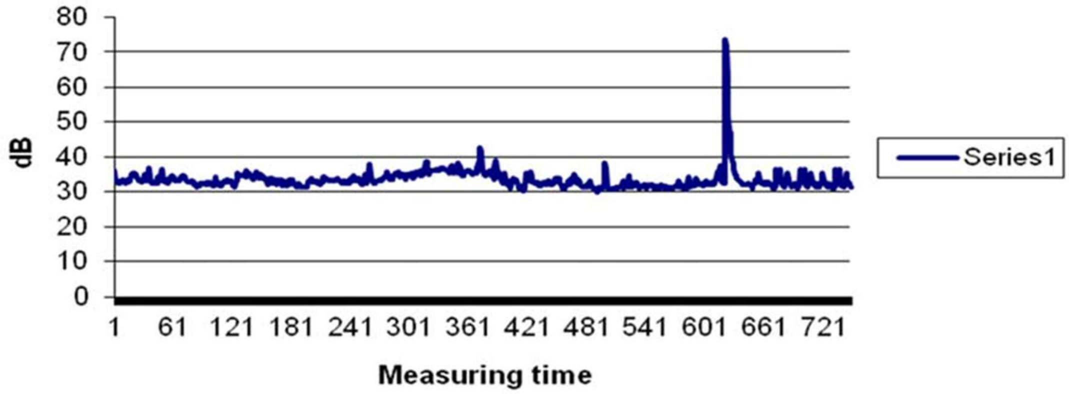

Figure 8-9: Sound pressure level increase during an open pit blast

The noise intrusion during the different mine activities of the construction and operational phases is more within a radius of 500 m from the activities whereas at 2 000 m from the activities the calculated noise levels are in line or slightly above the prevailing ambient noise levels except during a blast when the noise intrusion is exceeding the prevailing ambient noise levels in such a manner that the increase will be widely audible outside the boundaries of the mine (see Table 8-22).

Table 8-22: Noise intrusion levels during a blast

Vicinity of the mine activities	120 m	400 m	800 m	1,180 m	1,600 m	2,000 m	4,000 m
Blast – daytime	46.5 dB	36.5 dB	26.5 dB	16.5 dB	11.5 dBA	6.5 dBA	4.5 dBA

The plant and open pit operations will take place on a 24-hour basis. The trees, vegetation and trees will reduce the noise by a further 3 dBA as the sound is propagated from the plant. The depth of the open pit operations will play an important role in the way the noise from the open pit is propagated from the activities.

The ground vibration and fly rock during a blast will have an impact on the houses within a radius of 500 m from the blast depending on the number of explosives which will be used for the overburden or seam blasts.

The noise impact on the environment and the people residing near the proposed mine will have to be proactively managed during the construction and operational phases. The residents will have to be informed of the anticipated shift in the prevailing ambient noise levels which will be temporary during the construction phase and more permanent during the operational phase.

8.3.1.3. Closure

Rehabilitation of open pits and disturbed areas as well as demolishing of plant infrastructure will result in the increase of noise and vibration during the closure phase. The noise impact on the environment and the people residing in the vicinity of the proposed mine will have to be proactively managed during the construction and operational phases. The residents will have to be informed of the anticipated shift in the prevailing ambient noise levels which will be temporary during the construction phase and more permanent during the operational phase. The vibration issue will have to be communicated to the residents whereby they are briefed on the different kinds of vibration and at which level damage to structures may occur. Permanent vibration monitors to be installed at the northern and western boundary of the proposed opencast mine.

8.3.1.4. Recommended Mitigation

8.3.1.5. Construction

Construction activities will be confined to normal working hours only whenever possible.

Noise monitoring will be undertaken at the noise sensitive areas, particularly upon receipt of any complaints.

Acoustic screening mitigatory measures such as enclosures and silencers will be implemented at any point source that generates a noise exceeding 85.0 dBA at 50 m from the source.

Adhere to IFC Environmental, Health and Safety Guidelines.

8.3.1.6. Operation

Blasts must be designed so that ground vibration levels not exceeding 10 mm/s at houses, particularly those immediately north of the smaller mine pit, and the air over pressure level of 134 dB and 120 dB is not exceeded near schools and/or churches.

Whenever possible, minimize the resulting environmental effects of blasting operations and recognize that the perception of blasting events occurs at levels of vibration well below those necessary for the possible onset of the structural damage, but which can concern occupants adjacent to the mining area.

8.4. Water Resources

The following section reviewed and updated the water resource impact assessment report by Golders Associate Africa Ltd (Golder 2020) and it evaluates the project-related impacts on water availability and quality during construction, operation, and closure.

8.4.1. Overview of Sources and Receptors

8.4.1.1. Sources

Normal operating conditions

Sources of potential impacts on water availability are as follows:

- Land clearance and earthwork activities and associated alteration of surface water runoff patterns during construction.
- Impoundment of surface water flows along the following catchments:
  - Gojo,
  - Arera,
  - Chalete
  - Kersa and
  - Birbir River
- Construction-related infrastructure that reduces the catchment area's efficiency.
- Surface water crossings or diversions (culverts, for example) that affect the flow of water around project infrastructure.
- Dewatering the pit as it is being used to keep the area dry and help with slope stability
- Pit dewatering operations ending, which caused natural groundwater levels to rise again. Here are some factors that can affect the quality of the water: Seepage from mine waste storage facilities

Emergencies and failures

Emergency scenarios and system breakdowns related to the TSF or WSD could affect surface water flows and quality, albeit these sources are improbable. As described in Chapter 2, storm water design elements were incorporated into the construction of this infrastructure to lower the likelihood of emergencies and failures..:

- TSF
  - An emergency spillway was designed for the TSF at its final height (Knight Piésold, 2020a).
- WSD
  - Designed with appropriate spillways so once the dam is full any overflow can be released without a risk of uncontrolled overtopping and erosion.

8.4.2. Receptors

The Tula Kapi Project is located within the Baro Akobo catchment. The Baro-Akobo basin is 76 000 km^2 in area, and forms the headwaters of the West Nile, which flows from Ethiopia to Sudan. Most of the project infrastructure is within the catchment of the Birbir River that flows across the westwards, then southwards, about 8 km from the Project site Within this catchment, the closest communities to project infrastructure are the Gojo, Arera, and Chalte.

8.4.3. Potential Impacts

8.4.3.1. Construction

WR01-CO: Discharges or runoff to surface water affecting water quality

There may be erosion during the clearing of land and preparation of areas for the TSF, WDs, and other mine infrastructure. This erosion could cause sedimentation in water resources further downstream. If this is not controlled and the downstream subsistence farmers are affected, a moderate importance rating is anticipated.

- Excavation and preparation of areas for the TSF, WD and other mine infrastructure.

- Road crossings may alter the banks and beds of streams. The crossings may alter the hydraulics at the crossings, which can result in downstream erosion if the required protection is not provided. Increased upstream inundation could also occur if the crossings are not sized appropriately for a 1 in 50-year recurrence interval storm.
- Erosion of the riverbank during construction of the proposed pump station. Because of the proximity to the Birbir River, erosion is possible during construction, which will lead to sediment deposits downstream. It is noted that the pump station site was selected due to exposed rock at the riverbank allowing proper foundations for the steel caisson. Hard rock excavation will therefore be required to place the foundation of the steel caisson below minimum water level of the river.
- Erosion along the pipeline route during construction of the trench. Construction of the trench for the 2 600 mm pipeline over the 6.48 km could lead to erosion from the sides, and if not adequately filled and re vegetated may cause erosion in the areas used by subsistence farmers. It is noted that construction of the pipeline is proposed to be done during the period following harvesting, in the dry season. This will allow the farmers to replant their crops over the pipeline in the next rainy season.
- Erosion of the riverbank during construction of the proposed pump station. Because of the proximity to the Birbir River, erosion is possible during construction, which will lead to sediment deposits downstream. It is noted that the pump station site was selected due to exposed rock at the riverbank allowing proper foundations for the steel caisson. Hard rock excavation will therefore be required to place the foundation of the steel caisson below minimum water level of the river.
- Erosion along the pipeline route during construction of the trench. Construction of the trench for the 2 600 mm pipeline over the 6.48 km could lead to erosion from the sides, and if not adequately filled and re vegetated may cause erosion in the areas used by subsistence farmers. It is noted that construction of the pipeline is proposed to be done during the period following harvesting, in the dry season. This will allow the farmers to replant their crops over the pipeline in the next rainy season.
- Due to runoff from the site, the usage of machinery could result in hydrocarbon spills that affect the soils and ultimately the water supplies. Although this impact's importance is probably not great, it should nonetheless be managed.
- Unplanned discharges or accidental releases (spills) of potentially contaminating substances may occur during all project phases. The potential impact associated with each release will depend on the source of the substance released, its characteristics (such as toxicity, acidity or alkalinity, flammability, etc.), volume and duration of release and sensitivity of the receptors.

Despite the control measures incorporated in the project design, unplanned spills or discharges could occur as follows:

- Hydrocarbon spills from maintenance areas, fuel storage or vehicle filling areas.
- Chemical spills in the processing plant or from chemical storage areas.
- TSF discharge via the emergency spillway if design conditions are exceeded.
- TSF discharge in the event of catastrophic failure.

The significance impact rating from the land disturbance on surface water is expected to be moderate. The significance of this impact from spillage from mechanical equipment is likely to be low.

Table 8-23: Impact WR01-CO: Discharges or runoff to surface water affecting water quality

Impact WR01-CO: Discharges or runoff to surface water affecting water quality		
Type	Direct	
Project phase/s:	Construction	
Consequence	High	Medium
Probability	Possible	Low
Significance rating	Initial impact: medium (-)	Residual impact Low (-)

<u>Management measures</u>

- Develop and implement an ESMP and/or Storm water Management Plan and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- The plan should address diversion, excavation, handling excavated material and extent of excavations.
- Minimise the footprint of disturbance, as far as practicable.
- Properly designed culvert crossings to pass the design flood with minimum backwater, shall be constructed at all river/stream crossings. The approaches and exits from the river crossings must be protected to prevent erosion
- Erosion protection should be provided upstream and downstream of the crossing to limit the erosion impacts of the crossing.

- The water will be used for dust suppression on site, and, if the water quality meets the target water quality standards, then the water can be discharged to the river system in a controlled manner
- Storage of new and used oils in bunded areas
- No co-handling of reactive liquids or solids
- Creation and monitoring of an inventory of chemicals held on site
- Storage of hazardous or toxic substances securely and controlled use thereof
- Availability and accessibility of HAZOP sheets of all chemicals
- Management of topsoil stockpiles as described in the ESMP
- Roads need to be maintained and any erosion ditches formed along the road need to be rehabilitated as soon as possible
- The main access road should be constructed furthest from aquatic environments
- The extent of impact can be minimised in the immediate area surrounding the rivers by ensuring effective management of stormwater and return water
- The impacts will be mitigated if the riparian zone is kept intact and no activity is allowed within the buffer zones
- Use existing access roads
- Adapt mining process to ensure continued rehabilitation during operational phase

Impact WR02-OP: Altered surface water flow regimes

8.4.3.2. Operation

Impact WR01-OP: Discharges or runoff and change to water quality

Impacted discharge waters have the potential to be generated in the following areas:

- Discharge of excess water from pit dewatering.
- Drainage from waste rock dumps.
- Drainage from the TSF.
- Storm water runoff from exposed surfaces.

Impacts associated with unplanned discharges or accidental spills are addressed in WR04-OP.

Pit dewatering

Excess water from pit dewatering will be discharged to the WD and pumped to the processing circuit. Geochemical test work shows that the water is expected to be suitable for direct release however monitoring will be carried out during operations to confirm that the water meets discharge requirements.

Waste rock dumps

As described above, geochemical investigations on waste rock samples from the pit reveal low risk of acid generation and metal leaching so surface runoff from the waste rock dumps is not expected to be acid generating or have elevated metals contents.

As required, drainage channels will be built through the waste dump slopes and surrounding waste rock dumps to route surface water flow to the settlement control ponds. Regular water quality testing will be done to check the quality of the discharge before the settling water in the ponds is released into the WD and the environment.

TSF

To recover supernatant water, a seepage interception and under drainage will be built in the TSF. A contaminant interception system that comprises of a trench and interception boreholes is suggested in order to manage the contaminated plume from the TSF effectively (GPT, 2020). The trench, which will start at the top of the clay layer and not go any deeper than 1 m, will be used to stop seepage. On the TSF side of the trench, free-draining permeable material will be used, and on the downstream side, impermeable material. To reuse the water for processing, it will be pumped back to the facility from where it was collected in these systems.

Stormwater runoff from exposed surfaces

The risk of erosion is increased where vegetation has been cleared and where steep slopes are created that result in an increased rate of runoff (this impact is described in Section 8.6.2). The flashy nature of rainfall runoff in the area means erosion and sedimentation are already occurring as part of the natural system, which is exacerbated by existing land use activities such as artisanal mining and crop cultivation. High sediment loads are already observed within the existing channels.

Erosion and sedimentation arising from the project will be managed using sediment control ponds committed to in the project design. Prompt rehabilitation of disturbed areas will minimise ongoing risks. As the closure and rehabilitation activities at the end of the life of mine will aim to specifically address erosion and sedimentation, the impact is considered reversible. Although proactive management can significantly reduce the amount of sediment loading in surface waters, it is unlikely that all diffuse sources can be totally managed. Some increase in sediment load is therefore expected.

The expected operational phase water quality changes are discussed by catchment below.

Gojo Catchment

Clean overflow from WD1 will be diverted past the TSF by the spillway/diversion. Water quality impacts within the Gojo catchment are therefore expected from the following sources:

- Seepage from the TSF and North WRD. The saturated tailings or waste rock seepage will drain into the local shallow groundwater system and move downstream with the prevailing groundwater flow. The contaminated groundwater may daylight in the watercourse as diffuse base flow or as springs
- Spill from the TSF. Should the pool on the TSF exceed the maximum allowable volume determined by the TSF design, excess pool water will be discharged to the downstream Gojo catchment via the spillway/diversion? The spilled water will be a mixture of plant process water, rainfall on the TSF, clean overflow from WD1, and clean runoff from the spillway catchment
- Runoff from the ROM pad and Ore Processing Plant. Contaminated runoff not captured by site water management measures may enter the watercourse

The following outflows from the mine infrastructure situated in the Gojo catchment have been modelled:

Table 8-21: Average outflows (in m^3/hr) from mine infrastructure in the Gojo catchment

Gojo catchment infrastructure	Water quality	Interstitial storage	Seepage	Spill/Losses	Settling Ponds
TSF	Dirty	70	1	1	0
ROM pad and Ore Processing Plant	Dirty	0	0	6	0
North WRD	Dirty	0	2	0	4
WD1	Clean	0	1	6	0

Notes: Dirty runoff from site will be controlled by measures such as bunds and settlement ponds. As a conservative estimate all modelled flow from the ROM pad and Ore Processing Plant has been considered to discharge to the Gojo catchment.

Based on the preliminary geochemical assessment, TSF process water is expected to have the following quality:

- pH greater than 8
- Arsenic generally less than 100 µg/ℓ
- Sulphate from 3 to 3 000 mg/ℓ
- Alkalinity from 20 to 500 mg/ℓ
- Lead ±0.04 mg/ℓ
- Copper ±0.6 mg/ℓ
- Zinc ±0.4 mg/ℓ
- Antimony ±0.07 mg/ℓ

Significant iron and manganese concentrations are expected in TSF seepage due to dissolution of carbonate minerals in the tailings.

The dissolved salt and metal load will be added to the baseline loading in the Gojo watercourse resulting in an increase in concentrations. The magnitude of the increase will depend on the actual TSF process water quality and the relative proportions of dirty water and clean runoff in the watercourse.

Immediately downstream of the TSF, dilution by natural runoff is likely to be limited and a significant increase in dissolved salt and metal concentrations can be expected. Precipitation of oxidised iron and manganese may occur where TSF seepage discharges into the watercourse. This may result in increased turbidity of the water and a decrease in pH.

Further downstream, dilution and sorption of metals on iron oxy hydroxides is likely to reduce dissolved metal concentrations and pH which may approach background levels. Turbidity is also likely to decrease as fine particulates flocculate and settle.

Those tributaries of the Gojo which drain the North WRD may receive groundwater contaminated by seepage from the WRD. Based on the preliminary geochemical assessment, drainage from waste rock is expected to have the following quality:

- pH generally neutral (6 to 8)
- Moderate salinity (sulphate from 500 to 1 200 mg/ℓ)
- Arsenic up to 1 mg/ℓ

The dissolved salt (especially sulphate) and metal load will be added to the groundwater baseline loading in the tributaries resulting in increased in-stream concentrations. The proportion of contaminated groundwater in baseflow is likely to be small compared to clean flows from natural runoff and groundwater. This may moderate the increase in dissolved salt and metal concentrations.

The biggest concern and unknown is the reduction of water to downstream water users. Even with the diversion, it is not clear what volume of water will reach the downstream water users (subsistence farmers and communities who use water for crop production as well as domestic use). The volume of water required by these downstream water users is also an unknown.

Arera Catchment

A modelled average seepage flow of approximately 3 m^3/hr from the West WRD (Option A and B) in the Arera catchment is expected.

The WRD seepage is expected to enter the shallow groundwater and discharge into watercourses. The dissolved salt load associated with the contaminated seepage will be added to the natural load in the watercourse.

Baseline water quality in each catchment may be affected by an increase in salinity (especially sulphate) and metal loading. Metal loading may be moderated by the presence of organic matter and iron oxyhydroxide particulates which may sorb and reduce the dissolved concentrations of metals such as Pb, Cu and Zn. However, the concentrations of arsenic and chemically similar oxyanions such as Se, Sb and Mo are not likely to be controlled by this process and could be elevated downstream of the WRD in the Arera catchment.

Note that the cone of depression from groundwater dewatering associated with the mine pit will capture both contaminated and uncontaminated groundwater from the Kersa catchments and divert it into the pit water management system. This will reduce the dissolved salt and metal loading from West WRD seepage but will also reduce groundwater baseflow to each catchment. As a first approximation, the water quality impact from the West WRD will persist, despite pit dewatering. However, this will need to be confirmed by the development of a geochemical source term for the WRD and groundwater modelling of contaminant transport in and around the pit.

Based on water balance modelling, the North WRD settling pond is only likely to spill in low probability (95th percentile) extremely high rainfall events. Therefore, the ponds are not expected to be a significant impact on catchment water quality, provided seepage from the ponds is minor relative to seepage from the WRD footprint.

Chalte Catchment

A modelled average seepage flow of approximately 5 m^3/hr from the South WRD in the Chalte catchment is expected. This flow will contribute salinity and dissolved metals to the shallow groundwater as described for the Arera catchment. However, the relative proportion of contaminated seepage to catchment flow is likely to be much lower in the Chalte catchment which has a larger area and contains a relatively smaller portion of the WRD footprint.

Site runoff from the explosives magazine and workshop is expected to be controlled by drains, bunds, and settlement structures. As a conservative estimate, site runoff may be expected to contribute dissolved salts and petroleum hydrocarbons to flow in the Chalte.

While local concentrated inflows of mine-contaminated water may be expected, the general impact on catchment water quality is expected to be low. A small increase over the baseline concentrations of dissolved salts and metals in the Chalte is expected.

Kersa Catchment

Note that with recent changes to mine development plan (i.e. change from a single, large WRD to three smaller WRDs), waste rock will no longer be stockpiled in the Kersa catchment

Birbir River

Contamination of the Birbir River by Hydrocarbon Spills

An estimated 70 ℓ/h diesel will be used at the pumping installation. This means that approximately 1 575 ℓ of diesel will be used for a 22.5-hour operational day. In this respect the diesel tanks will be filled every second day from a mine fleet fuel truck. This may lead to spills during the offloading of diesel to the storage tank, leading to hydrocarbon contamination to the river.

Table 8-15: Impact WR01-OP Altered surface water flow regimes

Impact WR01-OP Altered surface water flow regimes		
Type	Direct	
Project phase/s:	Construction	
Consequence	High	Medium
Probability	Possible	Low
Significance rating	Initial impact: medium (-)	Residual impact Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- A systematic water monitoring programme should be developed and implemented.
- All clean storm water around the proposed TSF should be diverted away. All stormwater generated within the footprint of the TSF should be controlled and internally managed
- Ensuring appropriate lining of the TSF with a layer of low permeable material (e.g. saprolite)
- Reduction in the pool size to minimize seepage rates
- Construction of sediment control ponds downstream of the WRDs to catch runoff from the WRDs
- Installing an under-drainage system above the lining to minimize the head imposed on it and, thereby, reducing seepage potential
- Installing groundwater-monitoring wells down gradient of the TSF
- Storage facilities for the storm water should take account of the run-off qualities and have appropriate engineered barriers in place to prevent unacceptable downstream water resource impacts. Such measures to reduce impacts may include, but not be limited to: reduction in the pool size to minimize seepage rates; active or passive water treatment (e.g., wetland); retention and use in the mine water circuit; retention and controlled release; and groundwater interception mechanisms (e.g. interception boreholes, trenches, reactive barriers)
- A database of water quality monitoring results should be developed to help identify long term trends in water quality.
- TKGM shall develop and implement a thorough plan for the treatment and release of water from the settling dams to the environment
- Construct field cells next to the WRDs filled with various waste rock materials and monitored for infiltration, drainage quality and drainage volume during the operational phase of the mine. This will provide invaluable site specific kinetic geochemical data that will be required for the prediction of post closure water qualities as a function of closure rehabilitation measures
- Intercept pit groundwater seepage before it enters the pits by dewatering boreholes. This will prevent contamination of the groundwater and can potentially be discharged directly to environment
- Prior to commencement of Phase 4, the water balance model which has been calibrated using collected data, must be updated to include the north mining pit

Impact WR02-OP: Altered surface water flow regimes

The greatest worry and unknowable factor is the decrease in water supply to downstream water users. Even with the diversion, it is unclear how much water will actually reach the people and subsistence farmers who utilize the river for both domestic and agricultural purposes upstream. It is also unknown how much water these downstream water consumers will need.

The impact was graded as low after mitigation due to the localized scale of such a diversion and the fact that it would only occur in the short-term. The river's flow may be hampered during construction as a result of earthworks or temporary diversions.

The impact on aquatic species and ecosystems is unknown because the effect of the shift in water amounts reaching downstream systems, in terms of lower volume as well as changes in seasonal flow patterns, has not been completely quantified to date. Aquatic communities and their habitats may be damaged if the volume or regime of a river's water level is substantially lowered.

The assessment of potential impacts relies on the cautious principle because the extent of the reduced flow to downstream systems has not been established. As a result, the impact's size was categorized as Unknown. The influence will last for a considerable amount of time since, despite starting during the construction period, it will continue as long as the TSF is present in the landscape. Impacts will occur at a regional scale, and the probability of the impact occurring as predicted prior to mitigation is definite.

The impact was graded as low after mitigation due to the localized scale of such a diversion and the fact that it would only occur in the short-term.

Decreased River Flows during Pumping

Pumping for 74 days from September to mid-November at a rate of 55ℓ/s may lead to reduced flow in the Birbir River that could impact downstream water users. Although the pipeline is designed for the transfer of water at 55 ℓ/s, it is noted that the transfer will only be used in years when lower than average rainfall is experienced in order to supplement water collected on site and stored in WD1 and the TSF run-off areas. This means that in years with above average rainfall the pipeline will not be used.

In this respect water will be transferred from Birbir River at the end of the rainy season to plant site until WD1 is at full supply level. This volume will be adequate to supply the Ore Processing Plant with water until the next rainy season.

As shown in Table 8-16, the abstraction rate will not exceed 0.5% of the Birbir River's minimum flow from September to mid-November.

Table 8-16: Birbir River abstraction rates compared to minimum monthly flows (Knight Piésold, 2020b)

Month	Percentage of flow abstracted for a given pump rate			
	25 ℓ/s	30 ℓ/s	55 ℓ/s	120 ℓ/s
January	0.4%	0.5%	0.8%	1.8%
February	0.5%	0.6%	1.1%	2.4%
March	0.6%	0.7%	1.3%	2.9%
April	0.7%	0.8%	1.6%	3.4%
May	0.7%	0.8%	1.5%	3.3%
June	0.3%	0.4%	0.8%	1.7%
July	0.2%	0.2%	0.4%	0.8%
August	0.1%	0.1%	0.2%	0.5%
September	0.1%	0.1%	0.2%	0.4%
October	0.2%	0.2%	0.4%	0.8%
November	0.2%	0.3%	0.5%	1.1%
December	0.3%	0.4%	0.7%	1.5%

In addition, as shown in Figure 8-17, there is a time lag of the flow in the Birbir River measured against the rainfall in the catchment area, allowing the above operating philosophy to have a minimal impact on the water users downstream.

Emergencies and failures

To examine the hazards of a large-scale failure, a preliminary evaluation of the effects of a dam breach was done for the TSF (Knight Piésold, 2020a). With a tailings filling elevation of RL 1 648 m and a crest elevation of relative level ("RL") 1 649 m, the study was conducted. The analysis used a "sunny day" failure scenario in which, as a result of negligence or a significant storm, the TSF pond was allowed to fill to the spillway invert elevation. The TSF then quickly collapses as a result of an unknown failure mechanism. The analysis used a total pond volume of 1.457 million m3.

The dam failure consequence classification of the TSF was based on number of criteria, including population, loss of life, environmental, cultural, infrastructure, and economic losses. A 'high' dam class was assigned to the TSF for the following reasons:

- One house was identified within the calculated inundation boundary. The permanent population at risk is estimated at 5 persons
- The loss of life due to a failure is expected to be less than 10 persons
- Significant loss of habitat is expected due to pollution of the downstream watercourse by tailings
- Significant areas of arable land may be impacted – restoration or compensation in kind will be required
- Flooding of local public access will disrupt public transportation

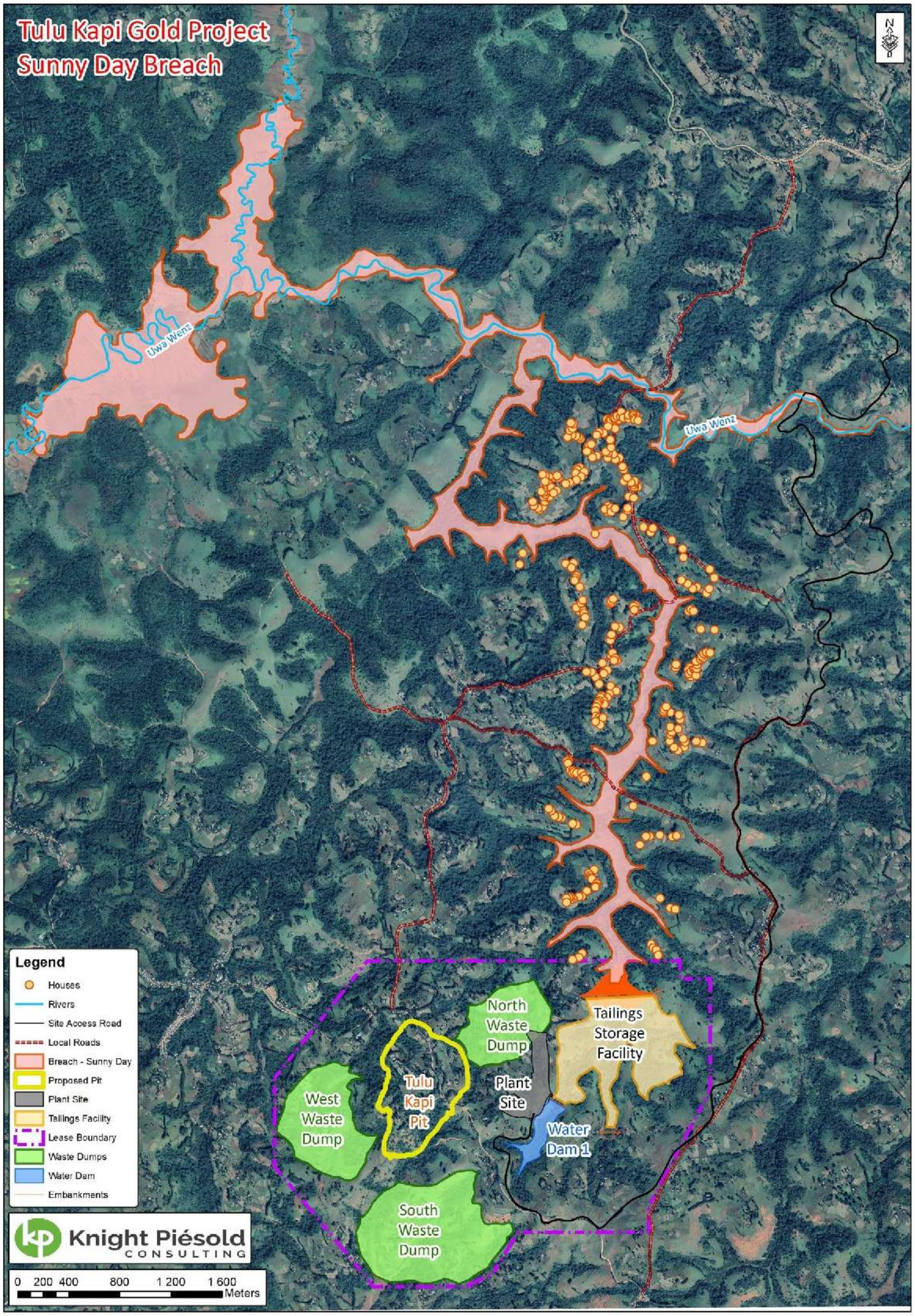

Figure 8-10: Sunny day breach failure scenario (Knight Piésold, 2020a)

Summary

The most significant impact to surface water flows is expected to arise from the diversion and retention of water within the TSF and WD. The modelled flows in the channels immediately downstream of the water storage dam and diversion channel will vary significantly depending on the operational configuration of the diversion. The impact was graded as low after mitigation due to the localized scale of such a diversion and the fact that it would only occur in the short-term. The river's flow may be hampered during construction as a result of earthworks or temporary diversions.

Catastrophic failure of the WD or the TSF would have high consequences, given the downstream population likely to be within the inundation area for the WD and potential inundation across the border. However, the probability of occurrence is unlikely and, as such, reduces the overall significance. It is noted that emergencies and catastrophic failures will be addressed as part of the site’s ongoing risk management programmes

Impact WR02-OP Altered surface water flow regimes		
Type	Direct	
Project phase/s	construction	
Consequence	high	high
Probability	Possible	low
Significance rating	Initial impact: High (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management, and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- TKGM will ensure that it develops and implements a water resources management plan that addresses water withdrawal and/or retainment and utilization, and discharges, as a minimum.
- Conduct a detailed dam break consequence assessment on the WD and TSF.
- Minimize the footprint of disturbance, as far as practicable.
- Water balance modelling is an on-going process and can be used to modify management and mitigation measures, based on updated flow and level monitoring.
- Review annual water consumption data to identify data to identify opportunities for reduced water usage across the site.
- Establish targets for reducing water consumption.
- Direct surface runoff unaffected by operation around project facilities to existing natural drainage lines.
- Install the designed sediment control structures downstream of the infrastructure to maximize capture of sediment on the license.
- Undertake regular inspections of surface water management infrastructure (i.e., diversion channels, trenches, culverts etc.) to ensure functionality as intended.
- Design road drains to reduce runoff flow rates and volumes, providing flow attenuation where necessary.
- Avoid creation of drop-offs and scour pools downstream of culverts.
- Carry out routine infrastructure checks (i.e., structural, procedural, and equipment-based checks).
- The pumping protocol at the end of the rainy season from September to mid-November at a rate of 55 ℓ/s should be followed, however it is proposed that river flows are monitored before and during the abstraction period to confirm that the reduction in flow is in fact negligible.
- A systematic water monitoring programme should be developed and implemented
  - The monitoring network should incorporate evaluation of the mine water system. It is recommended that the main focus is placed on:
  - The water levels in the various dams
  - Pit pumping
  - The monitoring of the barge return water from the TSF
  - Plant water intake and use.
  - Water balance modelling is an on-going process and can be used to modify management and mitigation measures, based on updated flow and level monitoring.
  - Conduct hydrological, hydrogeological, and geochemical modelling to determine the long-term pit lake water quality and water balance
- TKGM shall incorporate the evaluation of the mine water system in the overall monitoring network. The focus shall be placed on:
  - The water levels in the various dams

- Pit pumping
- The monitoring of the barge return water from the TSF

Impact WR03-OP: Seepage from mining wastes

TSF

The TSF design reflects the low permeability of the laterites and saprolites forming the basin of the TSF (Knight Piésold, 2020a) and incorporates 300 mm layer of compacted low permeability material. Where areas of the basin do not have in-situ low permeability material, it will have to be sourced from other areas within the basin.

Two-dimensional seepage modelling indicates that TSF seepage will gradually mix with and displace background groundwater and move downstream, as shown in Figure 2-17. The velocity of groundwater flow is estimated to be less than 1 m/year in the bedrock (KCB, 2020). The extent of the TSF seepage front is therefore expected to be limited to a few hundred metres from the TSF toe as shown

During construction, regular in-situ permeability tests (large double ring infiltrometer) tests or additional laboratory permeability test can be done to confirm the conditions of the basin.

No community water sources were identified immediately down gradient of the TSF;. Although dilution in the aquifer may reduce the concentrations of contaminants from any seeps that may occur, the potential contaminants may still cause negative impacts on down gradient water or future users.

Waste rock dumps

Following rainstorm occurrences, it is anticipated that rainwater will infiltrate through the WRDs. The seepage is supposed to be captured by an underdrain system, then after flowing through sediment management ponds situated at the lowest point of each WRD's footprint, discharged into the environment (Golder, 2015).

The underdrain system is made up of a chosen blanket drain made of rockfill that is installed at the bottom of natural drainage valleys. This blanket drain collects water flowing down the steep topography and acts as a positive drain for the WRD, which in turn lowers pore pressure in the waste fill. The blanket drain extends to the lowest point in the WRD footprint region, where it empties into the environment after passing through a sediment control.

The trapezoidal-shaped blanket drain will have a bottom width of 5 m and a thickness of 1.5 m. The drain will be built using carefully chosen rockfill and will follow the valley bottom's natural ground drainage slope. To reduce the chance that tiny particles may block the drains, an A6 geotextile will entirely enclose the blanket drain. The mining waste rock drains' choose rockfill grade is 500 mm to 4.75 mm (5% passing 4.75 mm).

Acid Rock Drainage

Static Testing of Humidity Cell Samples (Golder 2020)

- Particle size distribution analyses indicated that the bulk of the materials in the humidity cells occurred as gravel followed by sand and silt sized particles
- Mineralogical analyses indicated that pyrite was the dominant sulphide mineral both before and after kinetic testing. Minerals with a high to moderate neutralisation potential included calcite, ankerite, lizardite and chlorite. The most abundant mineral was albite, which generally has a low neutralisation potential. There were generally slight depletions in most minerals, with quartz and chlorite occasionally showing higher proportions in sample before than after kinetic testing, indicating heterogeneity in the samples. The percentage of quartz may also have gone up due to constant sum problem
- Total elemental analyses indicated that Ag, As, Ba, Cd, K, Mn, Mo, Na, Pb, S, Sb, W, and Zn are enriched in the rock units at Tula Kapi. These elements could be leached out of mine facilities when minerals weather. The elements, except for Mo and W, are potentially toxic to humans and are therefore Constituents of Interest ("COI")
- The paste pH of both the low-grade ore and waste rock materials was alkaline (pH = 8.2 to 8.5) indicating availability of excess Neutralisation Potential ("NP")
- The total sulphur content of the materials ranged between 1.3% and 2.2%, the bulk of this was sulphide sulphur (1.1% to 1.8%). Low values of both total and sulphide sulphur were recorded in the waste rock sample representing average sulphur content in albitised syenite. The highest sulphur content was recorded in the low-grade ore sample
- All the tested materials classified as PAG
- The carbonate neutralising potential was significantly higher than Bulk NP indicating that a significant

portion of the inorganic carbon was not generating alkalinity

Kinetic Tests (Golder 2020)

- The leachate from all the humidity cells was observed to be circumneutral (pH = 6.2 to 7.1) for the duration of the testing period
- Major cation (Ca, Mg, Fe, Mn, Al and Si), trace metal (e.g. As, Cd, Cu, Ni, Pb and Zn) and sulphate (SO4 release rates were generally low or decreased to low levels after a few cycles of testing under neutral pH conditions. Except for Cd, Co, Cu Ni and Zn that were occasionally detected, all the other trace elements remained below detection limit throughout the testing period
- Though SO4 and metal release rates were generally low, exceedances of water quality guidelines were noted occasionally for alkalinity, SO42-, pH, Ca, Fe, K, Mn and Ni. These metals and SO42- are likely to be leached from the waste rock and low-grade ore stockpiles under circumneutral pH conditions. Arsenic (As), Cd, and Pb, which are also potential COI, was quantified at the analytical method detection limit, which was equal to or higher than the water quality guidelines for the elements
- The tested materials revealed a low degree of sulphide reactivity despite the relatively high sulphide content (>1%). The sulphides contained in the humidity cell samples do not oxidize rapidly and release very low levels of acidity throughout the testing period. The low reactivity of the sulphides indicates that low rates of acid loadings will be released from the albitised syenite waste rock and low-grade ore materials. This need confirmation by site specific data, which can be obtained from in-field kinetic tests and wall washing during the operational phase of the Project
- The observed low sulphide reactivity could be related to the grain size (<0.1 to 10 mm) and texture (euhedral to subhedral) of sulphide grains and geochemical processes in the humidity cells, including precipitation of secondary iron hydroxides (e.g. ferrihydrite), which result in armouring of pyrite grains, hence reduced oxidation rates
- The CaNP rate was consistently higher than acid potential (AP) rate throughout the testing period indicating the slow reactivity of sulphides and availability of dissolving and fast reacting carbonates and silicates.
- Thus, albitised syenite and low-grade ore are not potentially acid generating (Non-PAG) in the short to medium term, as indicated by paste pH. However, the carbonate molar ratio indicated insufficient carbonates to buffer acidity in the long term. This was confirmed by time to depletion projections, which indicated that carbonates will be depleted much earlier than sulphides. Therefore, the low-grade ore and albitised syenite waste rock materials are PAG in the long term
- The release rates of Al, K, Na and Si indicated that silicates are potential long-term sources of NP in the waste rock and low-grade ore. However, silicates generally weather at a slower rate than pyrite. As a result, the low-grade ore and albitised syenite waste rock units are PAG in the long term. Site specific rates are required to confirm time for NP depletion and oxidation rates

Summary

- The low permeability of the laterites and saprolites forming the basin of the TSF
- The underdrain system has been designed as a selected rockfill blanket drain placed at the bottom of the natural drainage valleys
- Kinetic testing revealed that albitised syenite and low grade ore are Non-PAG in the short to medium term. However, the materials are PAG in the long term.

Impact WR03-OP Seepage from mining waste storage facilities		
Type	Direct	
Project phase/s	Operation	
Consequence	High	Medium
Probability	Possible	Possible
Significance rating	Initial impact: Medium (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- A waste material handling strategy should be formulated as part of the operating procedures for the WRDs as well as captured in an ARD management plan for the site. This strategy should be updated

regularly based on results from the on-going kinetic tests

- In order to effectively manage the contamination plume from the TSF, a contamination system which consists of a trench and interception boreholes is proposed (GPT, 2020).
- Construct rock blanket underdrainage systems to collect water seeping through the waste rock and to direct the seepage to the sediment control ponds
- Undertake further geochemical characterization of the tailings and waste rock to confirm the low risk of acid rock drainage and metal leaching.
- On-going kinetic testing will indicate water quality and confirm water quality is sufficient prior to any environmental release.
- Storm water containment and clean and dirty water should be separated.
- All storm water generated within the footprint of the TSF should be controlled and internally managed.
- Where possible, place the acid generating altered waste rock (albitised syenite and quartz vein in the centre part of the WRDs or in a similar fashion be encapsulated with as much non-PAG waste rock material (ultramafic silicates syenite and diorite/basic dyke).

Impact WR04-OP: Unplanned spills or discharges to surface water

Throughout all project phases, unintended discharges or unintentional releases (spills) of potentially contaminated substances are possible. Each release's possible effects are influenced by the substance's origin, properties (such as toxicity, acidity or alkalinity, flammability, etc.), volume and duration of release, and receptor sensitivity.

The process plant is concrete bounded with a lined emergency runoff pond to contain spillages. The fuel storage tanks are also concreted bounded with concrete used in maintenance areas together with standard containment facilities for hazardous chemicals, lubes, and oils. Despite the control measures incorporated in the project design, unplanned spills or discharges could occur as follows:

- Hydrocarbon spills from maintenance areas, fuel storage or vehicle filling areas.
- Chemical spills in the processing plant or from chemical storage areas.
- TSF discharge via the emergency spillway if design conditions are exceeded.
- TSF discharge in the event of catastrophic failure.

Both ground and surface water resources, which are used by communities and are mentioned in the consequences above, could possibly be impacted depending on the source of the spill and the trajectory of any inadvertent releases to the environment. When it's not raining or during the dry season, spills are less likely to cause a big problem since they may be halted, contained, and cleaned up without causing much damage. Nevertheless, during the rainy season, such spillages might be quickly mobilized downstream with potentially more severe impacts. The use of standard management procedures, which aim to limit the likelihood of spills occurring and the degree of any damage should a spill occur, can lessen the potential effects associated with spills of poisonous or hazardous materials.

The TSF was created to prevent the formation of a pool adjacent to the main wall in order to prevent hydrological connectivity with the downstream channel. The likelihood of exceeding these design events is extremely low, and any overflow will safely discharge into the downstream channel via the emergency spillway. Under these circumstances, any emergency discharge is anticipated to have a low impact discharge due to the strong flows in the downstream channels and rainfall that will considerably dilute it.

As described in Impact WR02-OP , an unlikely large scale failure of the TSF would result in an inundation area. The location of the TSF and proximity to downstream receptors means relatively low risks to these populations, however, impacts on ecological receptors is expected to be higher.

Impact WR04-OP: Unplanned spills or discharges to surface water		
Type	Direct	
Project phase/s	Operation	
Consequence	Medium	Medium
Probability	Possible	Low
Significance rating	Initial impact: Medium (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.

- Carry out routine infrastructure checks (i.e., structural, procedural and equipment-based checks).
- Ensure full containment of areas with high pollution potential (such as vehicle workshop areas and chemical storage areas).
- Treat, evaporate or dispose of any polluted water collected in these areas as a hazardous material.
- Ensure any hazardous substances are stored with a containment capacity of at least 110%.
- Implement standard procedures for the transport, handling and storage of hazardous substances to minimize the risk of accidental spills.
- Put in place spill management procedures to minimize likelihood of spills and facilitate prompt response in the event a spill does occur.
- Refueling is to take place at the dedicated refueling station, where practicable.
- All vehicle and equipment cleaning and maintenance must be undertaken on a concrete surface which drains to an oil water separator.
- Maintain an up-to-date register of all chemicals, reagents or hydrocarbons stored or used across the site.
- Personnel working with hazardous substances should be trained in the appropriate handling, storage and disposal requirements.
- Ensure no chemicals, reagents or hydrocarbons are stored on bare ground.
- Ensure chemical storage containers are labelled, and that labels are intact and legible.
- Ensure MSDS sheets are provided at the point of storage and that these are intact and legible.
- Provide staff awareness training on the potential HSE risks and impacts and identified control measures.
- Effective prevention, containment, and remediation of soil and groundwater contamination will be implemented, in specific acidity and heavy metals pollution as presented in other sections of the ESIA And impacts assessment section
- Fuel/oil spills will be collected and treated according the waste management procedures detailed in the ESMP. Vehicles will be properly maintained to prevent spillage. Spill kits will be available on site.
- Buffer zones around rivers and wetlands will be established. Runoff water from the waste rock dumps, stockpiles, seepage drains, and contaminated storm water will be channeled into pollution control dams
- Regularly inspect of storage areas (i.e., storage containers/tanks and ancillary piping) to ensure they are not leaking or damaged.
- Regularly inspect retention facilities/structures (i.e., bunds, spill trays, etc.) to verify their integrity.
- Chemically contaminated soil must be removed and disposed of to a preselected safe location and remediation measures implemented.

8.4.3.3. Post-Closure

The expected post-closure water quality changes include the accumulation of water in the mine pits as well as discharges to the three mine-affected catchments.

Impact WR01-PC: Discharges or runoff to surface water affecting water quality

Pit lakes at sites with similar ore bodies indicate the following water quality:

- Generally neutral (pH 6 to 8)
- Moderate salinity (sulphate from 500 to 1 200 mg/ℓ)
- Arsenic up to 1 mg/ℓ (possibly associated with selenium, antimony, and molybdenum)

It is not clear whether the level of the pit lakes will rise to an elevation resulting in discharge to surrounding catchments. This will need to be established by groundwater and water balance modelling of the pits.

Gojo Catchment

It appears likely that the TSF will remain partially flooded by runoff within the TSF catchment. Therefore, a similar situation to the operational phase is expected to prevail after closure. However, process water quality will no longer be a contributor to tailings seepage quality. Seepage quality will depend on the relative proportion of seepage from saturated and unsaturated tailings. Over the long term this may increase the acidity and metal loading in seepage downstream of the TSF.

Arera Catchment

No significant changes in conditions within the waste rock are expected after closure. Therefore, the post-closure catchment water quality is not expected to be significantly different from the operational phase. This assumes that the settlement ponds remain effective at containing runoff, at least until waste rock capping and rehabilitation is established.

Over the long term, changes to seepage quality from the West WRD (Option A and B) may be expected due to variable rates of mineral dissolution. Provided the rehabilitation of the West WRD (Option A and B) is effective at reducing seepage volume, the dissolved salt and metal load in seepage is not likely to increase. However, this should be confirmed from detailed geochemical assessment and on-site monitoring.

Chalte Catchment

At this stage, the South WRD will be the key mine-related contaminant source in the catchment after mine closure. However, the risk associated with seepage and overflow from the pit will need to be established.

As for the Arera catchment, no significant changes to waste rock seepage quality are expected during the initial post-closure period. The contaminant loading from the WRD is expected to be small relative to the flow in the Chalte catchment.

Impact WR01-PC: Discharges or runoff to surface water affecting water quality		
Type	Direct	
Project phase/s	Operation	
Consequence	Medium	Medium
Probability	Possible	Low
Significance rating	Initial impact: Medium (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Carry out routine infrastructure checks (i.e., structural, procedural, and equipment-based checks).
- Ensure full containment of areas with high pollution potential (such as vehicle workshop areas and chemical storage areas).
- Treat, evaporate, or dispose of any polluted water collected in these areas as a hazardous material.
- Ensure any hazardous substances are stored with a containment capacity of at least 110%.
- Implement standard procedures for the transport, handling, and storage of hazardous substances to minimise the risk of accidental spills.
- Put in place spill management procedures to minimise likelihood of spills and facilitate prompt response in the event a spill does occur.
- Refuelling is to take place at the dedicated refuelling station, where practicable.
- All vehicle and equipment cleaning and maintenance must be undertaken on a concrete surface which drains to an oil water separator.
- Maintain an up-to-date register of all chemicals, reagents or hydrocarbons stored or used across the site.
- Personnel working with hazardous substances should be trained in the appropriate handling, storage, and disposal requirements.
- Ensure no chemicals, reagents or hydrocarbons are stored on bare ground.
- Ensure chemical storage containers are labelled, and that labels are intact and legible.
- Ensure MSDS sheets are provided at the point of storage and that these are intact and legible.
- Provide staff awareness training on the potential HSEC risks and impacts and identified control measures.
- Regularly inspection of storage areas (i.e., storage containers/ tanks and ancillary piping) to ensure they are not leaking or damaged.
- Regularly inspect retention facilities/ structures (i.e., bunds, spill trays, etc.) to verify their integrity.
- Chemically contaminated soil must be removed and disposed of at to a preselected safe location and remediation measures implemented.

- To ensure that any adverse impacts are reduced, the Project team must ensure that any accidental spillages or impacts to the aquatic and riparian ecosystems are cleaned up and rehabilitated immediately in accordance with the TKGM's Emergency Preparedness and Spill Response Plan

- A spill kit must be maintained on site to clean up any diesel immediately after the event. The contaminated material must be taken to an appropriate facility onsite and safely disposed of according to the TKGM's WMP
- Diesel stored on site should be in a bunded area

- Monitor the in-stream water quality (pH, EC, TDS, DO, and temperature) downstream during construction of the pump station on monthly basis. Information from this monitoring can be used to quickly implement management actions should a significant decrease in water quality downstream of the pump station be observed#
- Fuel/oil spills will be collected and treated according the waste management procedures detailed in the ESMP. Vehicles will be properly maintained to prevent spillage. Spill kits will be available on site.
- Carry out routine infrastructure checks (i.e., structural, procedural and equipment-based checks).
- Ensure full containment of areas with high pollution potential (such as vehicle workshop areas and chemical storage areas).
- Treat, evaporate or dispose of any polluted water collected in these areas as a hazardous material.
- Ensure any hazardous substances are stored with a containment capacity of at least 110%. Implement standard procedures for the transport, handling and storage of hazardous substances to minimize the risk of accidental spills.
- Put in place spill management procedures to minimize likelihood of spills and facilitate prompt response in the event a spill does occur.
- Refueling is to take place at the dedicated refueling station, where practicable.
- All vehicle and equipment cleaning and maintenance must be undertaken on a concrete surface which drains to an oil water separator.
- Maintain an up-to-date register of all chemicals, reagents or hydrocarbons stored or used across the site.
- Personnel working with hazardous substances should be trained in the appropriate handling, storage and disposal requirements.
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8.5. Groundwater Impacts

This section reviewed and updated the groundwater impact Assessment report by Golder Associates Africa ltd (Golder 2020) and provides an overview of sources and receptors considered in the assessment (Section 8.5.1) along with an outline of the methods used to evaluate project-related groundwater contamination followed by an evaluation of the impacts.

During scoping, it was determined that hilltop terrain, low groundwater storage, and relatively modest groundwater flows are the main reasons why groundwater flow isn't as significant of an operational or environmental problem. Groundwater inflow calculations rather than a groundwater model were considered to be sufficient at that time for the feasibility study.

The main pit's worst-case maximum groundwater effect radius has been assessed to be 811 meters away from the pit boundary. The three springs in this radius may have less spring flow as a result of the development, but because they are part of the project's infrastructure area and will inevitably be affected, they will no longer be open to the public.

Process water supply is not dependent on groundwater sources: storage dams will retain enough water for the process plant. Potable mine-site water requirements are modest and can be met by existing well supplies.

8.5.1. Potential Impacts

8.5.1.1. Construction

Impact GW01-CO: Groundwater Levels and Quality

The construction phase impacts on both water table levels and quality from design implementation and the engineering of water management facilities were assessed to be of a moderate significance. Internal surface water runoff containment could lead to seepage from the toe and slope face as well as enhanced (artificial) recharge to the underlying aquifers. Also, transecting groundwater preferential flow zones could lead to additional water make in the opencast workings. With mitigation, these significance ratings are reduced to low.

The potential environmental impacts on the water table during the construction phase are a reduction in base flow, and rainfall recharge. These impacts were assessed to be of a low significance. With mitigation of the management of the groundwater intercepted, the significance rating stays the same.

Seepage quality from the waste rock dumps could exceed background groundwater quality and contain the following elements of concern at levels which might exceed national guidelines As, Ba, Co, Cr, Cu, Mn, Ni, Pb, U and Zn.

Impact GW01-CO: Ground water level and quality		
Type	Direct	
Project phase/s	Construction	
Consequence	Medium	Medium
Probability	Low	Low
Significance rating	Initial impact: low (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Compaction of the waste rock and concurrent rehabilitation will minimize ARD risks and limit infiltration and runoff from the WRDs.
- A system of gravel drains provided below the compacted clay liner at the valley bottom of the TSF basin will intercept groundwater from springs and to provide dry working surface for the construction of the compacted clay liner.
- Water collected by the under-drain system will be conveyed to a sump equipped with a pump, which will be located downstream of the TSF main dam.
- The potential for ARD from the WRDs is limited, according to static geochemical testing, but to reduce the risk, a natural clay liner will be engineered on a test cell beneath the first WRD while ARD potential of seepage is confirmed in the field. • One of the important design elements is to maintain the drainage from the WRDs and drainage from the adjacent catchments as two separate water streams.
- Ongoing kinetic testing will show water quality and validate water quality is sufficient prior to any environmental discharge. It is advised to provide treatment for the rainfall runoff from the WRDs in the form of sedimentation ponds.
- Carry out hydrogeological test work to more precisely determine the hydraulic characteristics in the mining sites.
- Provide an alternative water source if project-related effects on village drinking water supplies are discovered.
- Create a conceptual and numerical model based on test results for the mine areas to reassess potential effects.
- As much as possible, reduce the volume that is abstracted during construction.
- Keep the site's water balance in check.

8.5.1.2. Operation and Closure

Impact GW01-OP: Ground water level and quality

Dewatering required for mining operations will lower the water table surrounding the mine development and could impact on local springs or dug wells.

The hydrogeological conceptual model suggests the springs in the area are associated with the saprolite / transition zone groundwater flow system, which is recharged by groundwater flows. Pit excavation and associated dewatering will reduce available water to the springs.

The site occupies a catchment divide, and therefore will not require significant stream diversion works and the impact of surface water runoff altering groundwater is insignificant.

It is anticipated that a proportion of the dewatering/depressurisation volumes will be recycled in the mine water supply. Where mine water volumes exceed demand requirements, effective disposal of mine water will be necessary. If appropriately managed, discharge to the surface water environment is the most cost-effective disposal option.

Any disposal plan should take due consideration of the water quality of receiving drainage and management of any potential erosion of drainages, sedimentation, impact on local vegetation and on local communities.

Impact GW01-OP: Ground water level and quality		
Type	Direct	
Project phase/s	operation	
Consequence	Medium	Medium
Probability	Possible	Low
Significance rating	Initial impact: Moderate (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- A system of gravel drains provided below the compacted clay liner at the valley bottom of the TSF basin will intercept groundwater from springs and to provide dry working surface for the construction of the compacted clay liner.
- Water collected by the under-drain system will be conveyed to a sump equipped with a pump, which will be located downstream of the TSF main dam.
- Static geochemical tests indicate a low potential for ARD from the WRDs, however, to minimise risk, a natural clay liner will be engineered on a test cell beneath the first of the WRDs while confirming the ARD potential of seepage in the field. On-going kinetic testing will indicate water quality and confirm water quality is sufficient prior to any environmental release.
- One of the key design principles is to keep the drainage from the WRDs and drainage from the surrounding catchments as two separate water streams. Provision of treatment in the form of sedimentation ponds for the rainfall runoff from the WRDs is recommended.
- Compaction of the waste rock and concurrent rehabilitation will minimise ARD risks and limit infiltration and runoff from the WRDs.
- Installing groundwater-monitoring wells down gradient of the TSF
  - The TSF includes an engineered barrier to reduce seepage to groundwater and the water course downstream. The engineered barrier can take the form of lower permeability materials combined with an under-drain system. The risk of downstream water resource impacts should be considered in defining the competence of the engineered barrier
  - Intercept pit groundwater seepage before it enters the pits by dewatering boreholes. This will prevent contamination of the groundwater and can potentially be discharged directly to environment
  - Rebound of the groundwater in the pits is an effective measure to reduce post closure ARD and ML due to the reduction in oxidation rates under a water cover
  - The post closure pit water quality should be assessed and modelled during the operational phase to refine the requirements for long-term water treatment to prevent downstream groundwater impacts
  - Continue monitoring shallow aquifers, near the TSF, WRDs and open pits. Monitoring shall continue until an appropriately qualified independent third-party establishes that steady state conditions have been achieved and there is no risk of contamination related to the areas mentioned above.

8.6. Soils

This section reviewed and updated the soils impact Assessment report by Golder Associates Africa ltd (Golder 2020) and provides an overview of sources and receptors considered in the assessment (Section 8.6.1) along with an outline of the methods used to evaluate project-related groundwater contamination followed by an evaluation of the impacts.

The soils in the project area exhibit variety as a result of the site circumstances (relief, landform position, slope, geology, and vegetation). The variability, according to field observations and laboratory analysis, largely follows the top sequence and the positions of the following types of land forms: the summit (crest), the shoulder (upper slope), the back slope (middle slope), the foot slope (lower slope), and the toe slope (valley bottom/depression).

The eroded material from the up-slope position was deposited in the valley bottoms (wetland soils), creating very young soils. Due to a higher water table, they have poor drainage and inhibit rooted. Since these soils were created from materials that were eroded on the slopes, they are typically quite fertile.

The major properties of the soils are deep, workable, and stable soils with clayey texture. Textural differences in the soil affect sorption of certain chemicals. Chemicals do not readily bind to sandy soils because of the lack of charge on these coarser particles, but they do bind to clay because of clay’s overall negative charge and large surface area. Thus, the Project area being clayey in texture is advantages to minimize the impact of mining activities.

The CEC of the studied soils are low, this presents considerable problem for land use, including environmental management, because in such soils the capacity of the soils to fix and store nutrients is very poor.

8.6.1. Overview of Sources and Receptors

8.6.1.1. Sources

The main sources of impacts on soils are associated with:

- Land clearance and earthwork activities.
  - Deposition of water-borne sediments
  - Aerial deposition of dust
- Project infrastructure changing surface water flows
- Vehicle movements throughout the project area.
- Unplanned spills or discharges.

8.6.1.2. Receptors

The health of the larger ecosystem is based on the health of the soils, which in turn support the provisioning (agricultural production) and regulating (climate regulation - below-ground carbon sink, water purification) services described in Section 7 with supporting ecosystem services like soil formation and nutrient cycling. Therefore, the ecological receptors and receptors of impacts on these ecosystem services (mainly the local communities) are the receptors of impacts on soils.

8.6.2. Potential Impacts

8.6.2.1. Construction and Operation

Impact SL01-C0P: Disturbance of Soil and Erosion

Land clearing and earthworks for the pits, processing plant, mine infrastructure, TSF, haul roads, and waste rock dumps will disturb the soils and change the landscape's character during construction and the mobile parts of operation. Due to compaction, reduced infiltration, and higher erosion potential, the soil structure (fabric) will be changed. Because soils include a lot of clay, they are resistant to disturbance. However, because of the steep slopes and soil type, there is a large possibility for erosion with plant loss. This is a serious issue that will have a significant impact on managing the soil and maintaining soil stability.

Development of the TSF, waste rock dumps, and processing plant will result in some soil sterilisation. Land will be impacted upon via:

- Sterilization of land for other and future potential uses, mainly via compaction

- Loss of soil where some soils have a favourable agricultural production potential

Exposure of soils in the mine license area, notably on haul roads, around the mine pit, TSF, diversion creek and processing plant will increase soil erosion via storm water runoff. Fine tailings discharging into water courses will result in increased suspended sediment loads. Increased turbidity in the streams may further impact on downstream users via poor quality drinking water and biodiversity impact (siltation of wetlands).

Impact SL01-C0P: Disturbance of Soil and Erosion		
Type	Direct	
Project phase/s	Construction and operation	
Consequence	Medium	Medium
Probability	Possible	Low
Significance rating	Initial impact: Moderate (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Minimise the footprint of disturbance, as far as practicable.
- Scalping (removal) of the upper layer of soil material prior to site disturbance from the TSF, waste rock dumps and processing plant areas should be in place. The scalped soil will be stockpiled, demarcated, and protected for rehabilitation reuse.
- Rehabilitate disturbed areas concurrently with operations where possible.
- Restrict use of vehicles/equipment to demarcated areas to prevent unnecessary expansion of the footprint of disturbance.
- Inspect disturbed, rehabilitated and sensitive areas such as riverbanks affected by project infrastructure for visual signs of erosion and/or deposition. If problems are identified, initiate remedial action.
- Carry out regular inspections for visual signs of erosion and implement appropriate remedial actions.
- Provide staff awareness training on the potential HSEC risks and impacts and identified control measures.

Impact SL02-C0P: Soil Contamination Due to Leaching of Soluble Chemical Pollutants

Aerial dust deposition (Section 8.3.2), water-borne sediment deposition, and contamination from unintentional discharges or spills can all have an impact on the quality of the soil. Contact with contaminated water can potentially contaminate soil. Although there is little chance that unintentional spills or leaks will harm soil quality, the EMP includes a methodology for cleaning up any such occurrences. Contamination of soils by petrol, diesel, other soluble mine contaminants and cement is likely to occur, especially along haulage roads and within the vicinity of the mine pit and workshops. Contamination of soils around the TSF and waste rock dumps are also areas of concern due to potential acid rock drainage.

Depending on the type of spill, contaminated soil may be treated on-site or removed for treatment. Through enhanced infiltration and soil de-nitrification by rainfall, altered drainage patterns or exposure of soils may result in the potential loss of nutrient and organic carbon stocks.

Minimizing the size of disturbed areas is the primary design strategy to mitigate the impact on soil and land capability. At the conclusion of the construction phase, topsoil that is assessed to be of good quality and has the necessary physical, chemical, and biological qualities will be stored and used as needed for area rehabilitation. The impact significance might be lessened via proper management and the deployment of erosion control methods, such as re-vegetation to retain and protect topsoil, because the topsoil would stabilize in a relatively short amount of time and loss of topsoil would be less likely.

Impact SL02-C0P: Soil Contamination Due to Leaching of Soluble Chemical Pollutants		
Type	Direct	
Project phase/s	Construction and operation	
Consequence	High	Medium
Probability	Possible	Possible
Significance rating	Initial impact: High (-)	Residual impact: Moderate (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Excessive soil contamination by fuel or oil spills will be collected to be treated
- Vehicles will be maintained regularly and kept in a good working order.
- Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. Vehicles and mine machinery will be operational mostly along haulage roads and within specific areas, thus confining any pollutants to specific areas.
- Fuel and oil tanks and dispensing areas will be isolated to capture any spills. Vehicle servicing, repairs and washing will be in isolated, controlled areas. Workshops will have hard floors and sumps to capture any fugitive oils and greases.
- It is proposed that the TSF be designed with a clay liner and cover with a breaker layer which should significantly limit contamination once proven.

8.7. Biodiversity

This section reviewed and updated the biodiversity impact Assessment report, which was compiled by Golder Associates Africa ltd. in 2020 (Golder 2020), and provides an overview of sources and receptors considered in the assessment (Section 8.7.1) along with an outline of the methods used to evaluate project-related air emissions followed by an evaluation of the impacts.

8.7.1. Overview of Sources and Receptors

8.7.1.1. Sources

Impacts on biodiversity are caused by environmental changes brought about by the Project's implementation. This chapter's earlier evaluation of these direct modifications concluded that, are:

- Land clearance and earthwork activities.
- Changes in surface water flow regimes.
- Changes in water quality.
- Increased noise and vibration.
- Changes in air quality.

In addition, the project-related changes may be exacerbated indirectly by, for example, increased demand for natural resources that may result in further land clearance beyond that required for the project.

8.7.1.2. Receptors

The project area has a relatively large human population and is defined by a dominant human system overlay (i.e. a strong human-ecological system coupling, *sensu* Scholes 2009). Indeed, all land cover types are extensively used by local communities for various livelihood purposes, and the entire Project area and its surrounds are essentially agricultural landscapes

'Forest' patches throughout the Project area are actively farmed for coffee. Despite their 'natural' appearance, both vegetation structure and composition are noticeably dissimilar to natural forest patches. In accordance with IFC Performance Standard 6 (2012), forested patches in the Project area are thus classified as 'modified' habitat. Similarly, 'cultivated land', sites of built infrastructure (e.g. 'tenant house'), and those with a disturbed categorisation (e.g. 'degraded land' or 'nursery for coffee') are classified as 'modified' habitats.

The 'Bush land (grazing)' cover class comprises open grassland habitat, which, despite being heavily grazed by domestic livestock, retain the structure and function of natural grassland. Accordingly, these areas are classified as natural habitat, in line with IFC PS6 (2012).

Pursuant to the above rationale, the majority (92%) of the Project area is classified as modified habitat, with the remaining 8% natural habitat. Table 5-8 provides a breakdown of the hectares and relative percentage proportion of modified and natural habitat, while Figure 5-26 shows the delineation of modified and natural habitat in the Project area.

The focus of the impact assessment is on the key biodiversity features rather than features that are widespread, unthreatened, and resilient. The key biodiversity features (ecological receptors) considered in the assessment are:

- Habitats of high biodiversity sensitivity, i.e., where most of the sensitivity for various life forms has been identified
- Vulnerable, endangered, or critically endangered species.
  - White-backedVulture (Gyps africanus) – critically endangered
  - Hooded Vulture (Necrosyrtes monachus) – Critically endangered
  - Tawny Eagle (*Aquila rapax)-Near threatened*
  - Bateleur (*Terathopius ecaudatus)-Vulnerable*
  - Woolly-necked Stork (*Ciconia episcopus)- vulnerable*
  - Black-crowned Crane (*Balearica pavonine) – Vulnerable*
  - Erlanger's Grassland Frog (*Ptychadena erlangeri)- -Near threatened*

8.7.2. Potential Impacts

8.7.2.1. Construction

Impact BD01-CO: Habitat Loss and Fragmentation

Habitat degradation due to Land clearing

This section focuses on habitat loss associated with vegetation clearance activities. Habitat loss is the transformation of environments to the extent that the habitat can no longer support the species present, which can occur through direct habitat removal, fragmentation and/or degradation.

The impacts associated with land clearance activities will primarily occur during the construction phase due to vegetation removal (clearing and grubbing) and stripping of topsoil within infrastructure footprints, excavation and grading, extraction of construction materials from borrow pits, and stockpiling of materials.

Vegetation clearing is the greatest potential impact to floral communities under the proposed mining activities. All described vegetation communities are likely to be affected by this impact. Although the natural areas usually have the highest ecological integrity and conservation importance (as it contains the highest number of flora and fauna species), there has already been significant impacts in the MLA due to anthropogenic influences, and in particular intensive and extensive farming practices. Vegetation communities are likely to be impacted on a small spatial scale in comparison to the total extent of the vegetation communities' area in the region.

Habitat Degradation due to Dust

Increased dust may occur in the vicinity of the mining pits, Ore Processing Plant, haul roads and WRDs. Dust will be caused by activities such as excavation of the pits, hauling ore or waste along dirt roads, dumping ore at the Ore Processing Plants and dumping waste at the WRDs. Dust in the area will be greatly increased in the dry season due to the nature of the soil in the area, with very small particulates. Dust settling on plant material can reduce the amount of light reaching the chlorophyll in the leaves, thereby reducing photosynthesis, which in turn reduces plant productivity, growth, and recruitment.

This impact will most likely be moderate due to the existing impacts in the MLA and the fact that a number of roads in the area are already currently being utilised and the existing impact of dust is already quite high

Habitat Death or Injury due to construction of the Pump Station and Pipeline

Small and less mobile species may be trapped, injured, and killed during vegetation clearing and earthworks. Fauna that are of concern in this regard include fossorial mammals (e.g. moles, rodents), nesting birds (ground and tree nesting), reptiles, and amphibians. Due to the small footprint of the proposed development in an area generally characterised by modified habitat, as well as the fact that the Keley-Tulu Kapi road is frequently used by people, the likelihood of death and injury of fauna occurring as a result of the construction and operation of the pump station and pipeline was rated as low, and the overall significance was also rated as low post mitigation.

Loss and Disturbance of Aquatic Habitat

The following proposed activities could impact on the macro-channel and riparian vegetation:

- Riparian vegetation removal. Riparian vegetation is important for bank stabilization, habitat, flood control and is an important supporting feature within the food chain. Clearing and construction activities could
- Lead to increased erosion potential. Within the Birbir River, this will be transported downstream, while in the first and second order tributaries with limited flow, this silt with settle out and smother habitats
- Bank disturbances from heavy machinery gaining access to the river

Aquatic habitat loss and alteration (macro-channel and in-stream) could occur during the construction phase when earth moving machinery will be active. The margins of the Birbir River are densely vegetated, providing favourable habitat for smaller fish and fish fry. Construction activities may result in possible bank destabilisation, increased erosion potential and exotic vegetation encroachment. Due to the role these habitats play, the impact of losing or altering them was rated as moderate prior to mitigation. Due to the expected small footprint and nature of the development, it is believed that with the correct management, the significance of the impact can be reduced to low.

The main in-stream disturbances are expected to result from temporary sedimentation, arising from earthworks adjacent to the channel (pump station) and along the pipeline route. Sediments that make their way into the in-stream channel are likely to be flushed downstream under periods of high flow. The loss and disturbance to of aquatic habitat during the operational phase was rated as low due to the magnitude and scale of the operation and the fact that once constructed there will be little in-channel disturbance.

Habitat degradation due to Spillage of Harmful or Toxic Substances

Harmful or toxic substances that may affect the biota of the MLA if they were to enter the system include:

- Diesel or other fuel
- Gearbox or engine oil
- Process chemicals, such as cyanide and concentrated heavy metals
- Other chemicals

The spillage of harmful or toxic substances may impact on the fauna and flora of the area in a number of ways. Direct pathways include ingestion of the substances by fauna species resulting in toxicity in that individual, uptake of toxic chemicals by the roots of plants which may lead to toxicity in individual plants and chemicals entering the other systems due to contact (through the skin, leaves or stems). Indirect pathways include the ingestion of contaminated plants or animals by other species. The predation of contaminated animals by both other animals and humans is a common occurrence during chemical contamination due to these animals being sluggish, and less likely to escape predation, due to chemical toxicity.

The relatively low probability, scale, and magnitude of the effect of chemical spills, however, limit this to a low impact level. Furthermore, the project footprint already shows considerable signs of degradation, thereby, further lowering the likelihood of this impact having a considerable impact in the area.

Habitat degradation due to disturbance of biodiversity due to vibration and noise

Vibration and noise will have an impact mainly on fauna species in the immediate vicinity of the mine, haul roads, Ore Processing Plant and WRDs, due to the heavy machinery utilised for the extraction and transport of the ore. Vibration can affect a number of subterranean fauna taxa, such as burrowing mammals, reptiles and arthropods. Vibration effects these animals by causing the collapsing of burrows and causing these animals to leave the area. Noise will also affect a wide range of taxa including avifauna, mammals, reptiles, amphibians, and arthropods. Avifauna, especially songbirds, and amphibians may find it difficult to find mates in areas of increased noise. Mammals, reptiles, and arthropods may find increased noise disturbing and therefore move away from the area.

The impacts of vibration and noise may be substantial in ecosystems in tropical areas due to the, usually, high biodiversity in the area. The area in question in this study is, however, already substantially degraded due to agriculture and other anthropogenic disturbances in the area. The area which will be affected by vibration and noise is also very small in comparison with the available habitat of these kinds in the region. It should be expected that most fauna species will abandon the immediate vicinity of the mine during operations. A few species that thrive in areas of high disturbance (for example crows and ravens) will increase in numbers.

Species of conservation concern

- Endemic and Threatened Floral Species

Among the total 244 species of vascular plants (both wild and cultivated), there are nine species and subspecies that are endemic to the floristic region of Ethiopia. Only ***Brillantaisia grotanellii*** has been assessed as fulfilling the near threatened category

- Endemic and Threatened Fauna Species

Most of the fauna species are not of conservation concern and the habitat loss for these species is of low significance. However Impacts on White-backedVulture (Gyps africanus) and Hooded Vulture (Necrosyrtes monachus) are significant concern as the species are.

Summary

- All described vegetation communities are likely to be affected by this impact.
- Although the natural areas usually have the highest ecological integrity and conservation importance (as it contains the highest number of flora and fauna species), there has already been significant impacts in the MLA due to anthropogenic influences, and in particular intensive and extensive farming practices. Vegetation communities are likely to be impacted on a small spatial scale in comparison to the total extent of the vegetation communities' area in the region.
- The duration of habitat loss is a long-term effect as it will persist until the infrastructure is removed, and, although rehabilitation and re vegetation of disturbed areas will be undertaken during decommissioning and closure, some habitats will not be able to be restored and others may require a longer time investment to restore ecological processes and vegetation.
- The degraded nature of much of the vegetation in the area, as well as the very small footprint size of the TKGP in relationship to the total area of each of the vegetation communities, indicate that the cumulative impact of the vegetation clearing caused by the development is likely to only have a moderate impact on each of these vegetation communities prior to implementation of mitigation measures.
- Increased dust may occur in the vicinity of the mining pits, Ore Processing Plant, haul roads and WRDs. This impact will most likely be moderate due to the existing impacts in the MLA and the fact that a number of roads in the area are already currently being utilised and the existing impact of dust is already quite high.
- Due to the small footprint of the proposed development in an area generally characterised by modified habitat, as well as the fact that the Keley-Tulu Kapi road is frequently used by people, the likelihood of death and injury of fauna occurring as a result of the construction and operation of the pump station and pipeline was rated as low, and the overall significance was also rated as low post mitigation.
- Aquatic habitat loss and alteration (macro-channel and in-stream) could occur during the construction phase when earth moving machinery will be active. Due to the role these habitats play, the impact of losing or altering them was rated as moderate prior to mitigation. Due to the expected small footprint and nature of the development, it is believed that with the correct management, the significance of the impact can be reduced to low.
- The spillage of harmful or toxic substances may impact on the fauna and flora of the area in a number of ways. The relatively low probability, scale, and magnitude of the effect of chemical spills, however, limit this to a low impact level. Furthermore, the project footprint already shows considerable signs of degradation, thereby, further lowering the likelihood of this impact having a considerable impact in the area.
- Vibration and noise will have an impact mainly on fauna species in the immediate vicinity of the mine, haul roads, Ore Processing Plant and WRDs, due to the heavy machinery utilised for the extraction and transport of the ore. However, already substantially degraded due to agriculture and other anthropogenic disturbances in the area. The area which will be affected by vibration and noise is also very small in comparison with the available habitat of these kinds in the region. It should be expected that most fauna species will abandon the immediate vicinity of the mine during operations. A few species that thrive in areas of high disturbance (for example crows and ravens) will increase in numbers.
- There are threatened and endangered species in the project area.

Impact BD01-CO: Habitat Loss and Fragmentation		
Type	Direct and indirect	
Project phase/s	Construction	
Consequence	Moderate	Moderate
Probability	High	Possible
Significance rating	Initial impact: High (-)	Residual impact: Moderate (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Minimize the footprint of disturbance, as far as practicable.
- Restrict use of vehicles/equipment to demarcated areas to prevent unnecessary expansion of the footprint of disturbance.
- Limit land clearance within sensitive and ecologically important features as far as practicable (i.e., 'none fixed' components, such as lay down areas, temporary crossings etc.).
- Disturbed areas will be graded and re-vegetated as quickly as possible, and plants and trees of conservation importance will be replanted.
- Soils contaminated by spills will be collected and treated according the waste management procedures detailed in the ESMP.
- Minimize disturbance to wetland habitat outside the direct footprint by clearly demarcating the construction areas and limiting all activities to these areas.
- Offset enhancement of wetlands downstream of the TSF will be conducted to maintain ecological function. This may be conducted by such activities as planting, irrigation, natural and artificial contouring of lands, exclusion of cattle, and restoration of drainages to more natural physical shapes.
- Dust suppression will be used on unpaved roads, disturbed, or excavated surfaces, and loading sites.
- The proposed water supply pipeline should follow and be placed as close to the Keley-Tulu Kapi road as possible
- Topsoil stripped during construction should be stockpiled and used to rehabilitate disturbed areas
- A suitable rehabilitation programme should be developed and implemented in all disturbed areas. The programme should include active re-vegetation, using locally occurring indigenous grass and tree species
- Areas that should be considered priority sites for stabilisation and rehabilitation post-construction, should they be negatively impacted, include:
    - I. first and second order stream crossings;
    - II. the BirBir River, and
    - III. any vegetated areas along the pipeline route that may not be already impacted (i.e. coffee).
- An Alien Invasive Species Control Programme must be developed and implemented

Impact BD02-CO: Changes in surface water flows affecting Ecological Receptors

This section focuses on changes in surface water flows associated with the construction of project infrastructure. Much of the project infrastructure is in the catchment headwaters, which represent the main sources of fragmentation of the surface water channels.

Physical disturbance will also occur in terms of altering current hydrogeological and hydrological and channel properties. This will also have an impact on the ecological system. The impacts will begin during construction and extend well beyond closure

The assessment of potential impacts relies on the cautious principle because the extent of the reduced flow to downstream systems has not been established. As a result, the impact's size was categorized as Unknown. The influence will last for a considerable amount of time since, despite starting during the construction period, it will continue as long as the TSF is present in the landscape. Regional impacts will take place, and it is certain that they will happen in the manner projected before any mitigation measures are taken.

The scale of the impact can be reduced to moderate and the extent to local with the implementation of the necessary mitigation measures with regard to the release of clean diverted water back into the downstream system, but the residual impact still has a considerable relevance.

As these species are unable to distinguish between healthy and possibly dangerous water features, they may try to colonize this area. The TSF supernatant pond will thus represent a new permanent but continually changing surface water feature in the landscape. Therefore, the TSF will need common safety precautions to stop intrusion.

During the building period, in-stream and bank disturbances may have an impact on the water quality at or below the pump station, and there is also a chance that improperly maintained heavy machinery could contaminate the water. The biotic communities will be impacted by changes in the in-situ water quality parameters (pH, EC, TDS, DO, and temperature), as well as water chemistry (such as hydrocarbons). Due to the localized nature of the development's effects and the pipeline's alignment with an existing road, the residual impact significance of a decline in water quality was evaluated low during construction.

The Birbir River's water quality is not anticipated to be significantly impacted by the pump station while it is in use. River water will be extracted, and the operation isn't expected to have any negative effects on the water's quality. Surface water runoff that enters the Birbir River may be contaminated, especially in the area near the power plant's storage and use area for hydrocarbons (500 kVA genset generator). The expected amount of diesel is 70 l/h. This risk can be controlled to have a minimally significant residual impact by strictly implementing the suggested mitigation strategies.

Sediment mobilisation

Because of the clearing of vegetation and disruption of the natural ground surface during construction, there is a chance that suspended particles will be mobilized. It is necessary to construct in-stream channels (such as the TSF embankment, WD1 and WD2, and diversion channels), however these activities will mostly be carried out during the dry season, limiting in-channel erosion. Runoff controls and sediment capture will be used to manage construction activities in other regions, however despite careful management, some increase in sediment load is anticipated. Sources of sediment mobilization will still exist during the remaining project phases, albeit to a smaller amount than during construction.

The magnitude of this increased loading is low given the highly tolerant aquatic communities adapted to the intermittent flow and sediment loading.

Impact BD02-CO Changes in surface water flows affecting ecological receptors		
Type	Direct	
Project phase/s	Operation	
Consequence	High	Low
Probability	High	Possible
Significance rating	Initial impact: high (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Footprint will be minimized through clear demarcation, disturbed areas will be graded and re-vegetated as quickly as possible, and plants and trees of conservation importance will be replanted.
- Soils contaminated by spills will be collected and treated according the waste management procedures detailed in the ESMP.
- Where possible, maintain buffer zones around riverine forest habitat.
- Minimize surface disturbance/activities within this buffer zone as far as practicable
- Install crossings perpendicular to the bank, where practicable.
- Avoid crossings on potentially unstable section of the channel (i.e., bends).
- Minimize disturbance to wetland habitat outside the direct footprint by clearly demarcating the construction areas and limiting all activities to these areas.
- Regularly inspect road crossings after high water events.
- Provide staff awareness training on the potential HSEC risks and impacts and identified control measures.

Impact BD03-C0: Habitat Alteration - Increased Colonisation by Exotic Species and Introduction of AIS

The disturbance in the area as well as the use of vehicles will create areas prone to colonisation by exotic species. The use of trucks in mining areas often assist with the propagation of these species due to the dispersion of seed. If allowed to spread these species may outcompete indigenous plants which will lead to a loss of habitat and vegetation,

Disturbances caused by vegetation clearing and earthworks can create conditions conducive to the establishment and rapid spread of alien invasive vegetation. If left uncontrolled, alien species can spread exponentially, suppressing, or replacing indigenous vegetation. This may lead to a breakdown in ecosystem functioning and a loss of biodiversity. Alien invasive plants could potentially establish in all areas where construction activities will disturb existing vegetation. Recognised alien invasive plant species that were commonly recorded in the study area and may become problematic include inter alia*; Ageratum conyzoides*, *Caesalpinia decapetala*, *Eichornia crassipes*, *Lantana camara*, *Opuntia ficus-indica*, *Parthenium hysterophorus* and *Prosopis juliflora* and *Ricinus communis*. During construction, the probability of the establishment and spread of alien invasive plant species is expected to be high, due to the disturbance of soils. It is believed that with the correct management, the significance of the impact can be reduced to moderate during both construction and operation.

Impact BD03-CO: Habitat Alteration - Increased Colonization by Exotic Species and Introduction of AIS		
Type	Direct and indirect	
Project phase/s	Construction	
Magnitude	Medium	Low
Probability	Low	Low
Significance rating	Initial impact: Medium (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Footprint will be minimized through clear demarcation, disturbed areas will be graded and re-vegetated as quickly as possible, and plants and trees of conservation importance will be replanted.
- An Alien Invasive Species Control Programme must be developed and implemented at both temporary construction sites and permanent operational sites. The programme must include:
- The use of both mechanical and chemical control treatments, as required
    - Provision for periodic follow-up treatments
    - Regular monitoring
    - The implementation of the programme should be overseen by an ECO officer during construction, and the SHEQ or Environmental Manager during the operational phase
    - Fences (or other suitable obstacle/deterrent) should be erected to prevent fauna gaining access to construction areas, such as open trenches
    - The handling, hunting, poisoning, and/or killing of onsite fauna by construction workers and contractors must be strictly prohibited
    - General noise abatement equipment should be fitted to machinery (i.e. genset) and vehicles
- Strip and store soils in an appropriate manner during construction so that they can be used in rehabilitation activities once construction is completed. Management will ensure no compaction occurs or alien invasive colonise the stored materials
- Clean vehicles and loads entering the Project area and reduce traffic volumes to prevent invasive plant species from colonizing the area

8.7.2.2. Operation

In general, operational phase impacts will be extension of construction related impacts. Impacts described above will be extended through operational life of mine. Operational impacts related to terrestrial biodiversity generated from mining activities are not likely to extend beyond the zone of influence of the construction impacts. Populations and communities effected by construction will start to rebound and certain species will adapt well to the mining operations (for example certain small mammals, crows, ravens).

The potential impacts related to release of hazardous substances and invasion by exotic species are discussed in more detail below since the impact varies from construction impacts.

Impact BD02-OP: Changes in Water Quality Affecting Ecological Receptors

During the building period, in-stream and bank disturbances may have an impact on the water quality at or below the pump station, and there is also a chance that improperly maintained heavy machinery could contaminate the water. The biotic communities will be impacted by changes in the in-situ water quality parameters (pH, EC, TDS, DO, and temperature), as well as water chemistry (such as hydrocarbons). Due to the localized nature of the development's effects and the pipeline's alignment with an existing road, the residual impact significance of a decline in water quality was evaluated low during construction.

The Birbir River's water quality is not anticipated to be significantly impacted by the pump station while it is in use. River water will be extracted, and the operation isn't expected to have any negative effects on the water's quality. Surface water runoff that enters the Birbir River may be contaminated, especially in the area near the power plant's storage and use area for hydrocarbons (500 kVA genset generator). The expected amount of diesel is 70 l/h. This risk can be controlled to have a minimally significant residual impact by strictly implementing the suggested mitigation strategies.

Spillage of Harmful or Toxic Substances

Harmful or toxic substances that may affect the biota of the area if they were to enter the system include:

- Diesel or other fuels
- Gearbox or engine oil
- Process chemicals such as cyanide and concentrated heavy metals
- Other chemicals

The release of hazardous or dangerous compounds may have a variety of effects on the local flora and wildlife. Direct channels for chemical entry into other systems include contact (via the skin, leaves, or stems) and ingestion by fauna species, which may cause toxicity in that individual, uptake by plant roots of poisonous compounds, which may cause toxicity in individual plants. Other species may consume polluted plants or animals through indirect paths. Due to their sluggishness and decreased ability to flee predators as a result of chemical toxicity, infected animals are frequently preyed upon by both other animals and people.

The relatively low probability, scale, and magnitude of the effect of chemical spills, however, limit this to a low impact level. Furthermore, the project footprint already shows considerable signs of degradation, thereby, further lowering the likelihood of this impact having a considerable impact in the area.

Supernatant pond

Significant iron and manganese concentrations are expected in TSF seepage due to dissolution of carbonate minerals in the tailings. The dissolved salt and metal load will be added to the baseline loading in the Gojo watercourse resulting in an increase in concentrations. The magnitude of the increase will depend on the actual TSF process water quality and the relative proportions of dirty water and clean runoff in the watercourse.

Immediately downstream of the TSF, dilution by natural runoff is likely to be limited and a significant increase in dissolved salt and metal concentrations can be expected. Precipitation of oxidised iron and manganese may occur where TSF seepage discharges into the watercourse. This may result in increased turbidity of the water and a decrease in pH.

Sediment mobilisation

In the operation phase, there is a risk that suspended solids will be mobilised because of movement of equipment and disturbance of the natural ground surface. Mining works within other areas will be managed by means of runoff controls and sediment capture but despite proactive management, some increase in sediment load is expected.

The upper catchment slopes where most infrastructure is located are steep and have low buffering in the form of vegetation and such potential impacts on the channels and their adjacent slopes could rapidly be mobilized downstream. The magnitude of this increased loading is low given the highly tolerant aquatic communities adapted to the intermittent flow and sediment loading.

Impact BD02-CO Changes in surface water flows affecting ecological receptors		
Type	Direct	
Project phase/s	Operation	
Consequence	High	Moderate
Probability	High	Low
Significance rating	Initial impact: high (-)	Residual impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Footprint will be minimized through clear demarcation, disturbed areas will be graded and re-vegetated as quickly as possible, and plants and trees of conservation importance will be replanted. Where
- Possible, local seed collection will be undertaken, and a native plant nursery will be developed and maintained. These efforts will be detailed in a line with a Vegetation Rehabilitation Plan which will be developed and implemented
- Soils contaminated by spills will be collected and treated according the waste management procedures detailed in the ESMP. Vehicles will be properly maintained to prevent spillage. All potentially dangerous

- Substances will be handled according to international best practice.
- TSF will be constructed so as to prevent contaminants migrating into the environment
- Maintain cyanide levels in the TSF at levels which are typically non-lethal to wildlife and livestock. In areas where cyanide levels exceed these safe limits, measures such as fencing, filling in collection
- ditches with gravel, and covering netting of ponds or impoundments, should be implemented to restrict access wildlife and livestock
- Dust suppression will be used on unpaved roads, disturbed, or excavated surfaces, and loading sites. Disturbance will be minimized whenever possible, and construction methods will be selected to minimize
- Dust generation. Stockpiles and loads of soils or aggregates will also be treated to prevent dust generation (e.g. mulching, covering, moistening, or applying pacifiers where appropriate). Traffic will be restricted to designated routes, and speed limits will be strictly enforced
- Open pit areas will be marked and natural barriers to prevent animals entering the area. Culverts and drift fences will be installed, and speed limits strictly enforced along roads to reduce animal mortality

8.7.2.3. Closure

Closure will result in a continuation of operational and construction related activities and impacts with a strong reduction of intensity and extent. Disturbed areas will be reclaimed with the general trend of re-establishing natural dominated communities onsite so that complete restoration can follow based on natural processes. Risks associated with closure, include potential for infestation of exotic species attempting to colonize recovering areas and increased likelihood of mine site drainage, including AMD.

8.8. Socio-Economy Impact

This section reviewed and updated the socio-economy impact Assessment report, which was compiled by Golder Associates Africa ltd. in 2020 (Golder 2020), and provides an overview of sources and receptors considered in the assessment (Section 8.8.1) along with an outline of the methods used to evaluate project-related air emissions (Sections 8.8.2.) followed by an evaluation of the impacts.

8.8.1. Overview of Sources and Receptors

8.8.1.1. Sources

The sources of impacts during the construction and operational phases are as follows:

- Direct employment opportunities (including income tax on salaries).
- Purchase of goods and services from suppliers.
- Payment of corporate taxes, royalty fees and export levies.
- Indirect supplier-related activity that occurs because of the procurement of goods and services for the project (such as expansion of business activities, procurement of further goods and services, associated job creation).
- Induced effects created by increased household expenditure (through direct and indirect activities) that supports employment at other providers of goods and services (i.e., retailers, restaurants, service companies).

8.8.1.2. Receptors

The main receptors of impacts are the surrounding communities, those active within the labour market, businesses, and the Government, with receptors spread across a wide spatial extent (i.e., within the Woreda, within the Wellega, Oromia Regional State and Ethiopia generally). These receptors vary in sensitivity so the focus of this assessment has been on their ability to respond to the change.

8.8.2. Potential Impacts

8.8.2.1. Construction

Impact SE01-CO: Increased Government Revenue and Capital Infusion

A large amount of money will be injected into the Ethiopian economy through the project in the form of construction capital expenditure. Corporate taxes, royalties (above the LOM), and income tax on salaries will all be paid directly to the government as another source of income. By purchasing products and services locally, direct capital infusion into the local and regional economies will be maximized wherever possible in accordance with the Mining Operations Proclamation No. 678/2010. There are currently a few Ethiopian businesses involved in the endeavour, and more are probably going to profit. At the Woreda and regional levels, this direct capital input is anticipated to result in a rise in economic activity.

The government typically decides how it wishes to use the Project's money once taxes and other payments have been made into the national treasury. Since 2014, Ethiopia has been a candidate for the Extractives International Transparency Initiative and is working toward compliance. The establishment of a framework for the government and the relevant corporations to disclose payments and revenues from the extractive industries is a requirement for candidateship in the EITI. The civil society may learn how these donations are managed on behalf of the people thanks to this transparency, which also helps businesses show how their investment benefits a nation.

Impact SE01-CO Increased Government revenue and capital infusion		
Type	Direct, indirect, and induced	
Project phase/s	Construction and operation	
Magnitude	Medium	Medium
Probability	Definite	Definite
Significance rating	Initial impact: High (+)	Optimized impact: High (+)

Management measures

- Follow EITI guidelines when it comes to the publication of data on payments made to the government.
- Establish and preserve positive connections with regional and national regulatory organizations that encourage and support high standards of accountability and openness for tax and royalty payments.

Impact SE-CO2: Direct Employment Generation

Direct employment opportunities generated by the project provide positive impacts or benefits to the local community and the government. TKGM has not yet determined the number of direct jobs created during the construction phases; however, about 600 to 800 jobs will be created based on the data from similar projects in Ethiopia.

The project's workforce will be larger during construction than throughout operations, although jobs during the building phase will only last for a short time. The bulk of workers won't be needed after construction is finished, even though some may be kept on for the operation phase.

It is anticipated that construction will take 18 months to complete. Additionally, one can typically anticipate a multiplier effect as a result of these employment chances, whereby the presence of construction workers results in the creation of indirect job prospects. Although estimating the precise number of indirect job opportunities and the resulting multiplier effect is outside the purview of this study, this multiplier effect will have favourable benefits for the local, regional, and national economies.

During the LOM, the number of employment opportunities increases from 56 at the start of the mining up to maximum of 329 in Year 6, thereafter the number of employment opportunities decrease each year down to 24 in the final year of the mine. During this period, most of the labour will be sourced locally, increasing significantly after the first 3 years as locals start to replace expats.

In addition to this, a multiplier effect can usually be assumed because of these employment opportunities, where indirect job opportunities are created because of the presence of employed mine workers and subcontractors. Whilst it falls outside the scope of this study to quantify the exact number of indirect job opportunities and the resulting multiplier effect, this multiplier effect will have positive beneficial effects on the local, regional and national economy.

It is strongly advised to take advantage of local employment options in all impacted kebeles to counteract potential economic displacement and sustain good community relations. However, it is acknowledged that without major capacity building, the scope of employment opportunities within the project-affected kebeles is likely to be constrained. As the first large-scale mining project in the Tula Kapi woreda, there is a high expectation of widespread project benefits, which if not properly handled could lead to anger from the community. Even though TKGM will provide training for its staff, it's feasible that non-locals will occupy jobs that require abilities. Therefore, the improvement in skill development and transfer may not be as great as initially thought, especially given the construction phase's relatively brief lifespan.

Impact SE02-CO: Direct employment generation		
Type	Direct	
Project phase/s	Construction and operation	
Consequence	Medium	Medium
Probability	Definite	Definite
Significance rating	Initial impact: High (+)	Optimized impact: High (+)

Management measures

- Develop and implement a Recruitment Management Plan that addresses:
    - Preferential hiring from the neighborhood, whenever possible.
    - Includes a corporate interpretation of local.
    - Procedures for revealing job openings and skill criteria.
    - Procedures for identifying and choosing workers that are fair, open, and transparent (i.e., to minimize the possibility of nepotism, recruitment fees, etc.).
    - Methods for educating and advancing local employees with the goal of maximizing local content in positions requiring semi-skilled and skilled labor.
- Particularly marginalized or disadvantaged groups in the key local
- Maintain an employee database including information on the employee's background, position, hours worked, training received, and pay and benefits.

- Provide appropriate preliminary vocational training programmes within the local primary sphere to boost skills and increase access to potential direct, indirect or induced employment opportunities.

Collaborate with authorities and other development projects in the region for potential skills development and training programmes.

Impact SE03-CO: Indirect and Induced Employment Generation

A project of this size and character will generate indirect and induced job possibilities due to the injection of money and the matching demand for products and services, in addition to the direct project personnel. Every direct job produced by the initiative should result in three more jobs, assuming an average multiplier of four.

As a result of the dearth of existing service providers in the project's local vicinity, it is anticipated that the majority of project-related goods and services will be purchased on a regional or national level. However, in-migration to the region will also boost demand for goods and services, which local company owners who are able to meet the surge in demand might be able to supply. Existing businesses and people with the financial resources and entrepreneurial skills to launch new businesses stand to benefit most from this opportunity.

The indirect and induced employment opportunities will increase the number of people that experience the project-related benefits described in Impact SE-CO02.

Impact SE-CO03: Indirect and induced employment generation		
Type	Indirect and induced	
Project phase/s	Construction and operation	
Consequence	Medium	Medium
Probability	Definite	Definite
Significance rating	Initial impact: High (+)	Optimized impact: High (+)

Management measures

- Create and implement a procurement plan that takes into account:
    - Create and distribute a procurement policy that specifies the general strategy for organizing, administering, and sourcing procurement activities.
    - Prioritization of procurement from the local area.
    - Processes for identification of procurement needs, along with a commitment to consider unbundling selected contracts to provide opportunities for smaller businesses to provide goods and services.
    - Processes for identification and selection of suppliers/contractors/consultants, ensuring it is undertaken in a fair, open and transparent manner.
    - Mechanisms to enhance procurement of goods and services from the primary local sphere, such as the purchase of goods from the local markets, early payment of suppliers (to improve cash flow), etc.
    - Mechanisms to enhance procurement of goods and services from vulnerable or marginalized groups within the primary local sphere.
    - Mechanisms to limit in-migration.
    - Mechanisms to ensure contractor activities are consistent with the objectives of the plan.
- Develop and maintain a database of relevant local vendors/businesses and their potential capacity to provide goods and services locally. Encourage them to participate in bids.
- Identify, track and record key project-related benefits generated including the recipients of the benefits and timeframes over which these were received.
- Collaborate with authorities and other development projects in the region for potential skills development and training programmes.

Impact SE04-CO: Influx of Population

The Project may result in an influx of population into the Project area looking to benefit from mine related activities and potential employment opportunities. Often these job seekers are unskilled and/or do not meet the labour and skills requirements of the mining operation, particularly in countries such as Ethiopia where mining is a relatively new venture. During stakeholder consultation, communities expressed concern that such an influx may lead to:

- The transformation of the existing culture of the local people
- Increased prevalence of communicable diseases and HIV/AIDS

- Conflict and violence between local and non-locals
  - Increased pressure on services and facilities
  - The increase in the number of drinking houses and bars
  - Security problems

Impact SE-CO03: Indirect and induced employment generation		
Type	Indirect and induced	
Project phase/s	Construction and operation	
Consequence	High	Medium
Probability	Definite	Definite
Significance rating	Initial impact: High (-)	Optimized impact:Medium (-)

Management measures

- Develop and disseminate a Procurement Policy that outlines the overall approach to planning, sourcing and managing procurement activities.
- Develop and implement a Procurement Plan that addresses:
  - Prioritization of procurement from the local area.
  - Incorporates a corporate definition of local.
  - Processes for identification of procurement needs, along with a commitment to consider unbundling selected contracts to provide opportunities for smaller businesses to provide goods and services.
  - Processes for identification and selection of suppliers/contractors/consultants, ensuring it is undertaken in a fair, open and transparent manner.
  - Mechanisms to enhance procurement of goods and services from the primary local sphere, such as the purchase of goods from the local markets, early payment of suppliers (to improve cash flow), etc.
  - Mechanisms to enhance procurement of goods and services from vulnerable or marginalized groups within the primary local sphere.
  - Mechanisms to limit in-migration.
  - Mechanisms to ensure contractor activities are consistent with the objectives of the plan.
- Develop and maintain a database of relevant local vendors/businesses and their potential capacity to provide goods and services locally. Encourage them to participate in bids.
- Identify, track and record key project-related benefits generated including the recipients of the benefits and timeframes over which these were received.
- Collaborate with authorities and other development projects in the region for potential skills development and training programmes

Impact SE05-CO: Physical and Economic Displacement

The proposed road realignments of the Guliso-Gangi road and the construction of the Genji-Keely road are expected to affect approximately 39 structures and 43 structures respectively in an 18 metre buffer (determined through analysing aerial imagery from 2012 and walking the proposed route) – see Figure 8-12. These structures are all located outside of the MLA. The proposed road realignments also pass through agricultural fields that include crops such as sorghum, maize, millet, barley and oilseed, as well as forested areas with eucalyptus trees and coffee plants. In addition, the proposed roads cross several waterways and bridges will need to be constructed over these.

The proposed power line construction will be affected approximately 36 structures in an 18-metre buffer (determined through an aerial imagery analysis, refer to Figure 8-12.

- The proposed roads and powerline buffer will affect 42 ha of agricultural land (which may contain standing crops), and 26 ha of forested land (which may contain coffee trees and artificial forests to provide shade to coffee trees). Table 8-15 provides a summary of the land use that is affected by the proposed road realignments and the powerline within an 18-metre buffer. The owners of these assets will need to be identified and appropriate compensation will need to be paid to the owners for the loss of structures and crops. The necessity to include these owners into the RAP will need to be determined.

Table 8-17: Land use surface areas for proposed road realignments and powerline route (Golder 2020)

Land Use	North eastern Realignment (ha)	South eastern Realignment (ha)	North Eastern Realignment (ha)	Powerline (ha)	Total
Agriculture	1.71	5.16	23.87	11.10	41.84
Degraded Land	0.71	0	2.26	2.77	5.74
Forest/Coffee plantation	6.45	2.06	5.95	11.62	26.08
Housing	1.25	0	0	0.61	1.86
Total	**10.13**	**7.22**	**32.08**	**26.10**	**75.53**

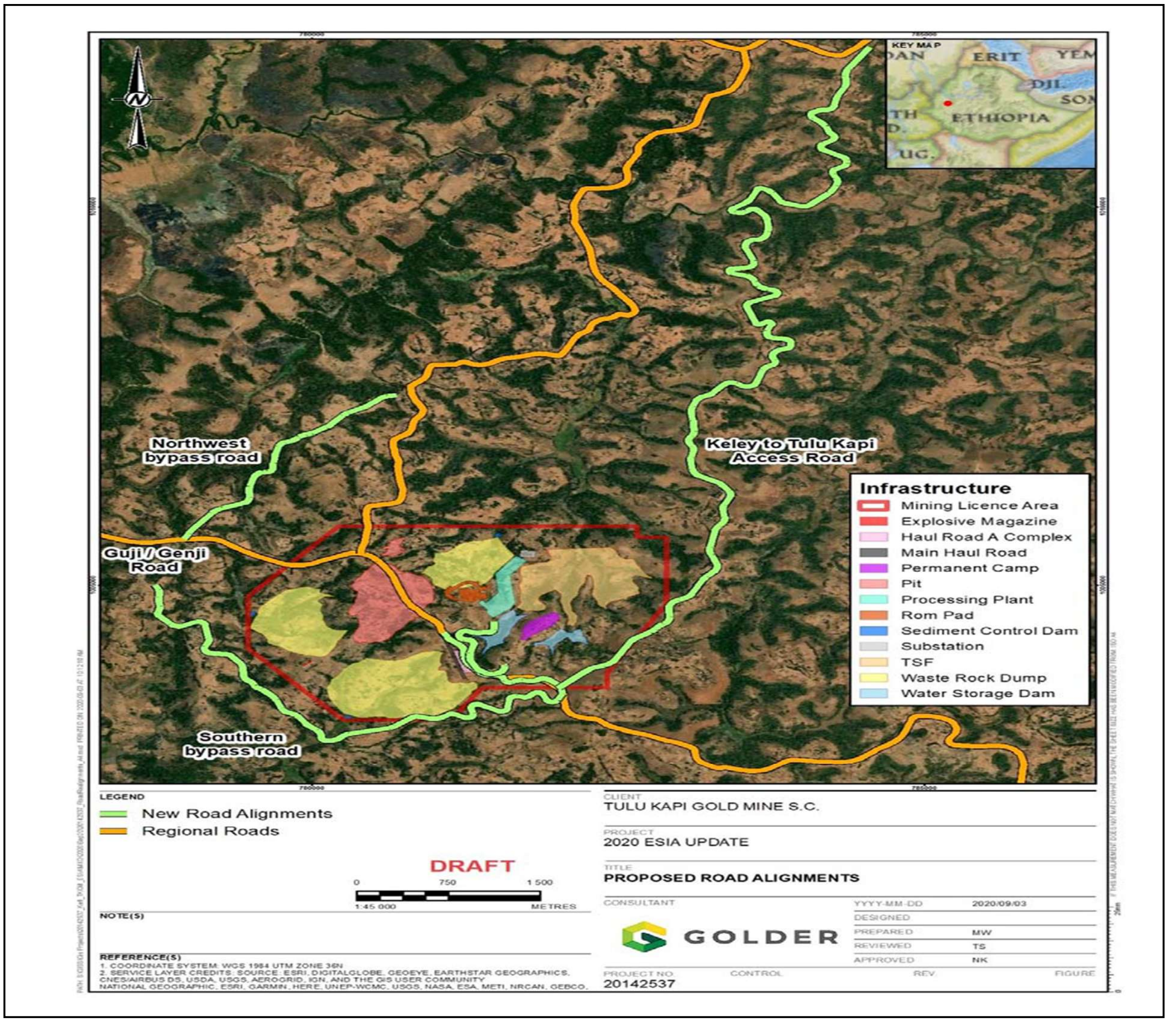

Figure 8-11: Roads in the LSA and proposed road realignments

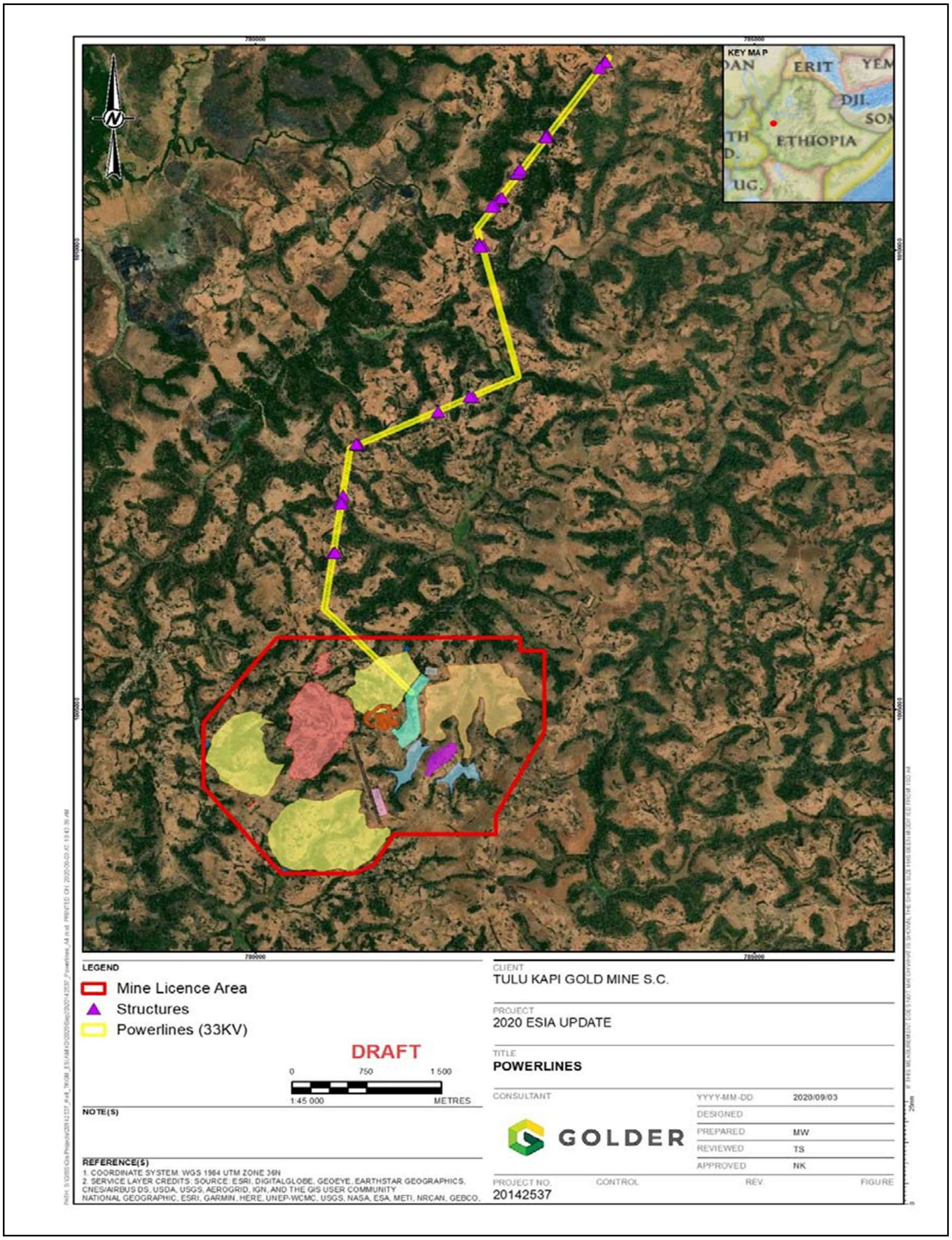

Figure 8-12: Structures affected by the proposed power line route

The Project area is characterised by numerous dispersed hamlets with structures built from mostly natural materials (mud, wood and grass, with mostly corrugated iron roofs). The communities have strong social ties with each other. Between 2012 and 2014, TKGM has undertaken significant efforts to reduce the Project footprint for required land take by 38% and reduced the number of Project affected households from 486 to 260. The land take for the mine and associated infrastructure (offices, tailings storage and mine housing etc.) in the revised exclusion zone will result in the physical and economic displacement of approximately 260 affected households with an estimated 1 430 persons. All permanent and economic assets (e.g. land, crops, coffee trees, etc.) belonging to these households will be lost.

In addition, the exclusion zone includes 3 churches and 1 health centre that will be physically displaced.

The proposed road realignment is expected to affect approximately 82 structures, whilst the proposed power line route is expected to affect approximately 36 structures. The exact number of displaced households because of the road and power line needs to be determined in the resettlement planning process. In addition, approximately 42 ha of agricultural land (with standing crops) and 26 ha of forested/coffee plantation areas stand will be lost because of the road and power line construction activities. Where economic assets (e.g. agricultural fields, crops and coffee trees and/or associated forested areas) are affected, this needs to be compensated and possibly replaced. The RAP needs to determine the extent of economic displacement and formulate appropriate entitlements.

Stakeholders raised numerous concerns regarding resettlement and compensation including that:

- Resettled households might not have the same access to fertile, arable land and social services and infrastructure and that appropriate compensation may not be paid thus exacerbating or causing
- unemployment, poverty, leaving them economically compromised
- That affected people may be negative toward the Project
- Resettled people may find it difficult to adapt to their new environment
- Resettlement will damage the social fabric (social integration and security system) of the affected peoples
- Resettlement and compensation will affect the well-being of women and children in particular
- Resettled people are not accustomed to using cash and cash compensation may thus lead to social disaggregation and poverty
- Many livelihoods are based on coffee plantations which take several years to establish making like for like compensation challenging

Households in the area sustain themselves primarily on subsistence farming and cash crops, such as coffee, sugar cane, maize, sorghum, rapeseed and teff, and livestock rearing on an average of 0.5 ha to 3.5 ha per household. Households land is generally located within walking distance with fields on higher ground and coffee plantations in the valleys.

Land in the region of the Project is fully utilised for subsistence activities including coffee production. Land-take for the mine and associated infrastructure and facilities will cause displacement of dwellings and subsistence activities and limited land is available as replacement.

Affected stakeholders placed a significant amount of emphasis on their concern regarding the loss of their coffee plantations and forests and the compensation they would receive for these.

Economic displacement refers to the loss of productive assets (including land and crops as well as assets that have the potential to be productive such as fallow land), usage rights or livelihood capacities as a result of a project's acquisition and transformation of land for project purposes. Such land take will remove a key source of subsistence resources, namely food, which is one of the foundations on which many area households base their livelihoods. Impacts at the household level may range from the loss of a very small portion of overall landholdings to the complete loss of all landholdings. This loss of productive land and potentially productive land (fallow land) will increase pressure on the household's remaining landholdings (if any) as well as other available lands in the area. International experience has demonstrated that loss of land is the main form of impoverishment of displaced rural households. Mitigation of this impact is challenged by the limited land that this available as replacement.

Economic displacement has been minimised through careful organisation of the Project layout to limit land take of productive lands. Where some economic displacement is deemed unavoidable, the Project must compensate eligible households for their loss in a manner that ensures the households have the resources to re-establish displaced livelihoods to an equivalent or improved level of benefit. The Project should endeavour, wherever possible, to offer land-based compensation and assistance strategies, including assistance in acquiring or accessing replacement land, including access to grazing land, forest and water resources; physical preparation of farmland; agricultural inputs; small-scale credit; and access to markets. Financial compensation for land and other economic assets should be calculated at the market value plus the transaction costs related to restoring the assets.

Land tenure in Ethiopia is held by the state and resettlement is government led. The RAP is currently being developed. Recent stakeholder engagement meetings undertaken by TKGM's social team with federal, regional and local government, as well as Project affected households indicated that the preference is to resettle households to nearby pockets of land, as well as in the Aba Sena Kebele. The associated impacts on these host sites will need to be determined in the RAP and potentially a separate ESIA.

The need for resettlement because of the impacts associated with reduced water availability, compromised water quality, safety of humans in relation to blasting and so on will be updated during the implementation phase.

An 'immoveable asset' survey will be conducted during RAP implementation to determine and / or verify land and asset ownership within the mine license area, as well as compensation eligibility and entitlement for each project-affected person / household.

Impact SE05-CO: Physical and Economic Displacement		
Type	Indirect and induced	
Project phase/s	Construction and operation	
Consequence	High	medium
Probability	Definite	Definite
Significance rating	Initial impact: High (-)	Optimized impact: Medium (-)

Management measures

- Develop and implement a resettlement action plan (RAP) for land acquisition and compensation in accordance with the resettlement policy framework
- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Minimize land take, as far as practicable
- Layout of the project should be improved to reduce land acquisition and relocation of habitations and productive areas.
- Ensure that displaced assets, such as structures, are compensated.
- Offer compensation for the loss of productive land, including agricultural land replacement, the creation of improved agricultural prospects through irrigation, fertilization, the promotion of agricultural techniqu, and other measures as outlined in the RAP.
- Promote the creation and implementation of community development and livelihood restoration initiatives, particularly those that emphasize the preservation and improvement of existing livelihood practices.
- These coffee plants may need to be reestablished over the course of five years, during which time households will need to be supported.
- Monitoring and mitigation of post-compensation should continue.
- Create a social map of the stakeholders who are both directly and indirectly impacted, highlighting, for instance, the sphere of influence and connections between various stakeholder groups. The stakeholder engagement plan ("SEP") will contain social mapping, which will be updated yearly.
- Establishing a grievance redress mechanism;
- Facilitate the provision of replacement or new crops to those affected by land take.
- Investigate the vulnerability of households with respect to changes in livelihood strategies.
- Facilitate development and implementation of livelihood restoration and community development programs, especially those that focus on restoring market and subsistence agriculture.# Facilitate

development of alternative, non-land-based livelihoods through training, inputs and access to markets, especially where options for restoration of land-based livelihoods are limited.
- Undertake ongoing monitoring and mitigation of residual impacts.
- On-going resource findings suggest the LOM will extend to at least 20 years. Infrastructure is being built to accommodate a 20-year LOM project.

Impact SE06-CO: Increased Pressure on Existing Ecosystem Services

The natural ecosystem in the Project area has been disturbed by agricultural activities. However, pockets of modified indigenous forest remain providing habitat to fauna and flora.

The local households are reliant on the ecosystems services to sustain their livelihoods both through agriculture and harvesting from the local forests.

A detailed survey during implementation of the RAP will highlight any modifications to the values if needed. At minimum, 622.3 ha of land will be directly affected by the Project's infrastructure, TSF, and exclusion areas.

This land take will affect households' direct relationship with the environment not only through physical displacement, but also through affected access to natural resources, ecosystem services and land for subsistence agriculture and coffee and fruit plantations. Pressure on available replacement land is expected to make the mitigation of this impact challenging and is likely to result in some households being forced to change their livelihood strategies. It is likely that while some households may be interested in the opportunity to change livelihood strategies, many will not want to change their traditional practices nor will many households be equipped to do so, thus the dislocation of households from access to ecosystem services may be a distressing and enduring experience for many households.

Impact SE06-CO: Physical and Economic Displacement		
Type	Indirect and induced	
Project phase/s	Construction and operation	
Consequence	Medium	Medium
Probability	Definite	Possible
Significance rating	Initial impact: Medium (-)	Optimized impact: Medium (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Minimize land take, as far as practicable.
- Develop and implement a resettlement action plan (RAP) for land acquisition and compensation in accordance with the resettlement policy framework
- Any clearing of natural forests will be done in accordance with the Forestry Conservation Development and Utilization Proclamation No 94/1994.
- Refine the Project layout to minimize the impact on land and natural resources.
- The local population's reliance upon aquatic and terrestrial biodiversity will be documented in the RAP and appropriate mitigation measures refined as needed.
- Provide "in-kind" compensation for the loss of land and natural resources on which the local communities are reliant to the extent possible.
- Extended baseline work should be done to determine households' dependence on ecosystem services and natural resources during the RAP implementation. In addition, investigations should be undertaken to determine affected households' willingness and interest in changing their livelihood strategies and encourage those households to alternative resettlement options.

Impact SE07-CO: Safety and Security Risks

Mining is known to have inherent dangers to one's health and safety. The mining industry and governments have made the health and safety of workers and host communities a top priority through laws.

Stakeholders specifically cited the 2010 San Jose Mine tragedy in Chile, where 33 people were trapped underground for 69 days, in raising the issue of occupational health and safety and the local capacity to handle emergency circumstances.

It is not anticipated that there will be a general understanding of the types of emergencies and how to react to them, or the capacity to do so, especially among the local people, due to the absence of large-scale mining in Ethiopia.

The Project region currently has a sparse road network, which has limited the surrounding populations' exposure to motorized traffic. During development and operation, the Project will unavoidably introduce mine-related vehicles and traffic, which could be anticipated to pose threats to the safety of the roads.

A lack of local occupational health and safety culture, inadequate health infrastructure and capability, and a low degree of mining experience are all current issues in Ethiopia. The infrastructure (tailings dam, processing, etc.) and operations (transportation, chemical storage, etc.) of the mine could pose health and safety threats to workers and communities.

Additionally, there is little expertise with big vehicles in the project area's towns. Currently, animals and pedestrians alike use the congested highways. In the Project area, there is little knowledge of driving safety and little road marking. Due to this, there is a chance that residents' livestock and mining vehicles will be involved in traffic accidents.

Plans will need to be made to both prevent and deal with operational health and safety problems, even though TKGM will consider these risks in the design of the operation. These plans will need to take into account the local environment in relation to the employees' and communities' levels of knowledge regarding accidents and emergencies involving mines.

To counter this potential impact, health and safety protocols must be implemented, including any necessary training. A health and safety management plan was created by TKGM and will be revised and developed concurrently with the feasibility study.

Impact SE07-CO: Safety and Security Risks		
Type	Indirect and induced	
Project phase/s	Construction and operation	
Consequence	Medium	Medium
Probability	Possible	Unlikely
Significance rating	Initial impact: Medium(-)	Optimized impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Provide staff awareness training on the potential HSEC risks and impacts and identified control measures.
- Prior to start of construction, TKGM will facilitate a health impact assessment which will inform its approach to both employee and community health and safety management. This health impact assessment will need to establish a baseline for community health (especially related to communicable diseases and sexually transmitted disease (“STDs”)).
- Prior to start of construction, TKGM will also facilitate completion of a Community Health and Safety Plan in collaboration with the Ministry of Health to address future populations of employees and their support networks.
- The Health and Safety Management Plan (“HSMP”) will be refined to ensure that it addresses all factors identified in the Traffic Impact Assessment, mine development plan, and ESIA. In addition, TKGM will:
- Continue implementation of its health and safety policy and adaptively manage changes as needed
- Continue training for all employees, contractors and subcontractors in the company health and safety requirements
- Develop a detailed Emergency Preparedness and Response Plan (“EPRP”)

- Communities and employees will need to be made aware of the potential dangers and emergencies that could result from mining activities and infrastructure
- TKGM's mine plan incorporates potential development of a new access road (as one of the alternatives), thus allowing exclusion of pedestrian and vehicular traffic, while maintaining existing pedestrian traffic along the existing route to Keley.
- TKGM will develop, disclose, adopt and implement a community health and safety plan which will include traffic and transportation risk management.

8.8.2.2. Operation

The project's operation phase is anticipated to have the following socioeconomic effects. Throughout the duration of the Project, effects on the influx of population, vulnerable populations, and safety and security are anticipated to persist.

Impact SE01-OP: Increased Government Revenue and Capital Infusion by the Project

The mine will invest heavily during the construction phase for the development of mine infrastructure, SE-CO01 above discusses this. To maintain mining operations, LOM capital expenditure (during the LOM and closure periods), and LOM operational expenditure (during the 7-year LOM), further investment will be needed in the operation phase. During the operation phase, the majority of the affects stated (above SE-CO01) will persist.

The funds allotted through the Community Development Plan, taxes paid to the local government for land compensation payments to those who were resettled, and infrastructure upgrades such as new roads, bridges, and social infrastructure all directly benefit the neighbourhood closest to the project.

The payment of taxes, wages, and purchases will all be part of the operations phase. The operational phase will see a reduction in the secondary and support industries that provided services to the construction teams due to a change in needs from the initial concentrated economic impacts from the construction period.

According to Ethiopian Law, the fiscal terms of the Tulu Kapi Gold Mine Project include the following:

- Royalty: 8%
- Corporate income tax: 35%
- Dividend withholding tax: 10%
- Government free carry: 5%

Additional applicable mine taxes include:

- Value Added Tax ("VAT") at a rate of 15% will be incurred on capital supplies and services received
- Customs Duties and Taxes
- Withholding Taxes
- Employee tax rate is progressive and ranges from 10% to 35%. Employers are required to pay the government 15% of salaries to cover social security and an 8% health levy on the salaries of local Employees

In accordance with Ethiopian Mining Proclamation 678/2010, the holder of a mining license is required to pay royalties depending on the sales price of the commercial transactions of minerals produced after mining operations begin. The mining proclamation sets 8% as the royalty rate for gold and other precious metals in Ethiopia. But from what we gather, TKGM and the MoM were able to come to an agreement on a decreased royalty rate and a corporate income tax rate of 25%.Only 6% of Ethiopia's income can currently be attributed to the mining industry. The goal of the mineral sector for the next 15 to 20 years is to build a diverse, globally competitive, environmentally responsible, and privately led mining industry that contributes at least 10% of Ethiopia's GDP and is led by the private sector. This will help Ethiopia's socioeconomic development and end poverty.

Impact SE01-OP Increased Government revenue and capital infusion		
Type	Direct, indirect, and induced	
Project phase/s	Construction and operation	
Consequence	Medium	Medium

Impact SE01-OP Increased Government revenue and capital infusion		
Probability	Definite	Definite
Significance rating	Initial impact: High (+)	Optimized impact: High (+)

Management measures

- Follow EITI guidelines when it comes to the publication of data on payments made to the government.
- Establish and preserve positive connections with regional and national regulatory organizations that encourage and support high standards of accountability and openness for tax and royalty payments.

Impact SE02-OP: Direct Employment Creation

During the LOM, the number of employment opportunities increases from 56 at the start of the mining up to maximum of 329 in Year 6, thereafter the number of employment opportunities decrease each year down to 24 in the final year of the mine. During this period, most of the labour will be sourced locally, increasing significantly after the first 3 years as locals start to replace expats.

In addition to this, a multiplier effect can usually be assumed because of these employment opportunities, where indirect job opportunities are created because of the presence of employed mine workers and subcontractors. Whilst it falls outside the scope of this study to quantify the exact number of indirect job opportunities and the resulting multiplier effect, this multiplier effect will have positive beneficial effects on the local, regional and national economy.

It is assumed most of the project-related goods and services will be procured regionally or nationally due to the shortage of existing service providers within the immediate project area. However, in-migration into the local area will also increase demand for goods and services, which could be provided by local business owners who are able to respond quickly to the increased demand. Those most likely to be able to capitalise on this opportunity will be existing businesses or those with financial capacity and business/ entrepreneurial skills that could set up new businesses.

The indirect and induced employment opportunities will increase the number of people that experience the project-related benefits.

Impact SE02-OP: Direct Employment Creation		
Type	Direct, indirect, and induced	
Project phase/s	Construction and operation	
Consequence	Medium	Medium
Probability	Definite	Definite
Significance rating	Initial impact: High (+)	Optimized impact: High (+)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Develop and disseminate a Recruitment Policy that outlines the overall approach to recruitment activities.
- TKGM will develop, disclose, adopt and implement the following management plans to enhance local employment opportunities:
    - Influx Management Plan: to identify and implement measures to manage in-migration, and avoid, prevent, and mitigate the direct and indirect adverse impacts associated with project-induced in-migration
    - Stakeholder Engagement Plan: to ensure that stakeholders, including local residents, are involved in the ESIA of the proposed Tulu Kapi Project
    - Recruitment, Training and Local Employment Plan: to identify and implement appropriate procedures for recruiting and training people from the local communities
    - Local Procurement Plan: to identify and implement appropriate procurement practices which engage local businesses in TKGM's supply chain

8.9. Social and Cultural Cohesion

8.9.1. Overview of Sources and Receptors

8.9.1.1. Sources

Sources of potential impacts on social and cultural cohesion are described below, many of which are secondary impacts associated with impacts described in previous sections, as follows:

- Wider gaps in income between people with and without jobs.
- The involvement of state or private security forces.
- Unjust remuneration for property and assets, whether actual or perceived.
- Unfair hiring practices, policies, and/or employment perks, whether actual or alleged.
- Unequal access to natural resources, whether actual or perceived.
- Layoffs of low-skilled local workers after the construction phase is finished.
- Unfair supply and procurement practices, whether actual or alleged.
- Unfair access to the project's community development programs, whether actual or perceived.
- An influx of people moving into the area in pursuit of potential employment possibilities. Receptors

The main receptors of impacts are people from the surrounding communities, specifically those who are considered more vulnerable.

Impact SC01: Increased Marginalisation of Vulnerable Groups

Increased wealth brought about by job opportunities (Impact SE02, and SE03 both CO&OP) may provide people with less time to engage in domestic and supplemental activities, which would lessen reliance within and across families.

The baseline data, which shows that families depend on one another and their neighbours for domestic tasks like fetching water, gathering wood, preparing food, etc., and livelihood tasks like field preparation and crop and fruit harvesting, which are done by both men and women, reinforces the possibility that this will happen.

Any decrease in participation in domestic and supplemental activities is likely to put more pressure on individuals who do not profit financially from the initiative, potentially making them more vulnerable. While this may have an effect on both men and women, it will put some groups at greater risk because they are less able to take advantage of direct employment opportunities, such as the elderly who are less able to perform the physical labour and women (including those in households headed by women), for whom it may not be culturally acceptable (because of a social system that is largely patriarchal) or practical (because of the expectation to balance domestic and productive roles) or both.

Therefore, it is crucial that community development programs (Impact Appendix Y) address pressures on people who do not profit financially from the project, especially the weaker groups within the kebeles.

Impact SE02-OP: Direct Employment Creation		
Type	Direct, indirect, and induced	
Project phase/s	Construction and operation	
Consequence	Low	Low
Probability	Possible	Low
Significance rating	Initial impact: Low (-)	Optimized impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Create and put into effect a management and monitoring plan for the environment and society that focuses on potential effects and related impact mechanisms.
- Identify, track, and keep a record of the major project-related benefits that were produced, as well as who received them and when.

- To keep track of prospective rises in products and services, establish and implement a food price monitoring system (i.e., for a typical consumer basket of items).
- Actively support programs that expand possibilities for women to make decisions for themselves, earn more money, and possibly have better futures.
- Conduct routine evaluations of the perceived difficulties and alterations in the quality of life in the communities impacted by the project.

8.10. Community Health and Safety

This section reviewed and updated the health and security impact Assessment report, which was compiled by Golder Associates Africa ltd. in 2020 (Golder 2020), and provides an overview of sources and receptors considered in the assessment (Section 8.7.1) along with an outline of the methods used to evaluate project-related air emissions (Sections 8.7.2.) followed by an evaluation of the impacts.

8.10.1. Overview of Sources and Receptors

8.10.1.1. Sources

The following sources of impacts on community health and safety have been evaluated earlier in this chapter:

- Changes in the environment through implementation of the Project:
- Reduced access to land for livelihood activities (SE05).

As such, this section focuses on the general project activities that may present risks related to accidents and injuries and changes in the disease profile.

8.10.1.2. Receptors

The main receptors of impacts are people from the workforce and surrounding communities, specifically those who are considered more vulnerable

Impact CHS01: Increased Disease Prevalence within Employees and Communities

The project area's present health profile reflects the state of the healthcare system and services as well as the pervasive poverty. According to the information received from the Genji Woreda, Respiratory Tract Infection (“RTI”), Rheumatoid Arthritis, and Malaria are among the top ten diseases that the people in the Woreda are facing.

The current level of communicable diseases such as STDs and HIV/AIDS in the Project area is unknown. However, it is the experience of mining operations in Africa that the influx of workers and opportunity seekers as well as the transient presence of transportation workers can lead to an increase in communicable diseases.

The interaction between the project workforce and local people will increase the potential for spread of some of these communicable diseases. The causes of this impact are anticipated to begin during the construction phase through the movement of non-local workers in and out of the project affected kebeles.

The possibility for certain of these infectious diseases to spread will grow as a result of interactions between project workers and local residents. The movement of non-local employees into and out of the project-affected kebeles is expected to be one of the reasons of this impact during the building phase. Although access to the surrounding community after business hours is discouraged, the majority of the construction and operations workforces will be housed onsite. However, workers may visit the neighbourhood on their scheduled days off.

The presence of project workers from other parts of Ethiopia and expatriate workers along with an influx of service providers and speculative job seekers, will result in an influx of predominately single males or males without their family, which may result in increased antisocial behaviours and associated lifestyle/infectious diseases. Antisocial behaviours in this context refers to substance abuse (sometimes associated with an increase in violence), the use of sex workers, and crime and violence. If not well managed this could lead to deterioration in public health and can cause lost productivity due to illnesses among workers. However, the spread of Sexually Transmitted Diseases may be limited by the cultural and religious norms of the local population, which strongly discourage promiscuous sexual activities. The health risks may be more severe for women who have limited access to health services due to a lack of female staff in health centres/ clinics and cultural constraints.

Impact CHS01: Increased Disease Prevalence within Employees and Communities		
Type	Direct, indirect, and induced	
Project phase/s	Construction and operation	
Consequence	Low	Low
Probability	Possible	Low
Significance rating	Initial impact: Low (-)	Optimized impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Foster an education and awareness program aimed at addressing anti-social behaviors (such as substance abuse and violence) in collaboration with pertinent partners, local leaders, and the Woreda/kebele authorities.
- Assist NGOs and the local health department in enhancing their initiatives to combat infectious diseases.
- Work with NGOs and the government of the Woreda administration to develop policies for HIV/AIDS, TB, and other potentially contagious diseases with an emphasis on prevention, control, diagnosis, and treatment.
- Work with relevant partners, local leaders and the Woreda/ kebele authorities to promote an education and awareness programme targeted at managing anti-social behaviors (i.e., substance abuse, violence).
- As part of the Emergency Response Plan, establish suitable communication channels with local and regional health organizations as well as leaders of potentially affected communities. This will cover the unlikely scenario of an infectious disease outbreak at the mine site or in the nearby towns.
- Keep an eye out for the appearance of significant pandemics via WHO alerts, and when necessary, put the Emergency Response Plan into action.
- Require contractors to comply with the company’s health-related policies and programmes.
- TKGM will support a health impact evaluation that will shape its approach to both employee and community health and safety management.
- TKGM will require contractors to comply with the company's health-related policies and programs.
- To address future populations of workers and their support networks, TKGM will promote the creation of a Community Health and Safety Plan in partnership with the Ministry of Health.

Impact CHS02: Creation of Permanent Surface Water Feature Increasing Malaria Incidence

Malaria is known to be a disease that is highly sensitive to ecological change, with altered disease incidence linked to habitat change (creating more suitable vector breeding sites, for example) and subsequent changes in land use activities (increasing human activity in previously inaccessible areas, for example).

Malaria is one of the top ten diseases in the area. The two main infrastructure components potentially associated with increased malaria prevalence are the WDs. Studies within Ethiopia have identified that malaria transmission intensified in communities located close to dams in lowland and midland locations.

Without mitigation, the significance of this impact is likely to be low. The magnitude of the impact of workers suffering from Malaria is expected to be very high (can be life threatening), but short-term in duration, and limited to the site only. The probability of occurrence is likely to be moderate. With mitigation, the probability of occurrence can potentially be reduced from moderate to low. The significance of the impact is likely to be low with mitigation.

The impact pre-mitigation is of medium significance and will require proactive environmental and social management strategies combined with conventional vector interventions to reduce the residual impact to low significance.

Impact CHS02: Creation of Permanent Surface Water Feature Increasing Malaria Incidence		
Type	Direct, indirect, and induced	
Project phase/s	Construction and operation	
Consequence	Medium	Medium
Probability	Possible	Low
Significance rating	Initial impact: Low (-)	Optimized impact: Low (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Implement an Integrated Malaria Control, Prevention and Treatment Programme that focuses on vector management, individual risk management, and limiting the effects of infection.
- Avoid the creation of mosquito breeding conditions through proactive surface water management during construction and operational activities.
- Collaborate with the local authorities to minimise development of settlements close to the WDs.

8.11. Archaeology and Cultural Heritage

8.11.1. Overview of Sources and Receptors

8.11.1.1. Sources

The sources of potential impacts on archaeology and cultural heritage include the land clearance activities during construction and operation.

8.11.1.2. Receptors

The receptors include the known archaeological and cultural heritage sites within the footprint of project infrastructure:

- Village/house ruins (or artefacts) – several sites are located within the footprint of project infrastructure, which are evaluated as being of medium significance.
- Modern burial markers – three single graves are located within the footprint of project infrastructure, which are evaluated as being of high significance.
- Unidentified surface or sub-surface remains.

Of these, the burial sites are of high importance to the surrounding communities, forming part of their cultural landscape.

8.11.1.3. Construction, Operation and closure

Impact ACH01-COP: Damage or loss of tangible and intangible cultural heritage

Demand for local pottery products may increase due to a population influx to the Project area especially during the construction and operational phase.

Economic competition with traditional goods from imported products and traders could diminish the livelihoods of traditional merchants and craftsmen without a plan for integrating new and current goods into the local economy.

Large scale economic and environmental development will alter aspects of the lives of local inhabitants, including in their material culture.

Some associated impacts to the traditional belief systems, trees of cultural significance and sites associated with native/local beliefs are anticipated.

In the case of resettlement or relocation, decreased access to traditional environmental resources, dissociation from current social structures, and familial separation could occur.

On land where burial places are located, strong ownership links between descendants and ancestors are anticipated. Land owners will rely on customary rights to land tenure in situations when there may be no evidence of legitimate property ownership. An impact of the project's development that would need to be mitigated is the destruction or removal of ancestral burials. According to FDRE Proclamation No. 209/2000, Article 7, human remains and burial sites are considered immovable cultural heritage and can only be relocated by dismantling.

Loss of traditional belief systems, cultural landscapes, and symbolic sites associated with traditional beliefs as a result of environmental change, migration, and dissociation from sources of traditional knowledge are a potential impact of the Project development.

Because of competing religious beliefs in the community, the socio-cultural impacts of addressing and mitigating the disruption of scattered burial sites throughout the Project area could exacerbate existing community differences thereby disrupting the status quo of the established social fabric.

Impact ACH01-COP: Damage or loss of tangible and intangible cultural heritage		
Type	Direct, indirect, and induced	
Project phase/s	Construction and operation	
Consequence	Medium	Medium
Probability	Definite	Possible
Significance rating	Initial impact: High(-)	Optimized impact: Medium (-)

Management measures

- Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
- Minimize the footprint of disturbance, as far as practicable.
- Commission an appropriately qualified archaeologist to perform a detailed walk-over survey of areas to be cleared prior to surface disturbance.
- Determine levels of management for cultural sites disturbed by the project footprint once defined in accordance with national regulations and stakeholder input.
- Develop a chance finds procedure to manage any previously unidentified archaeological or cultural resources uncovered during surface disturbance activities.
- Provide staff awareness training on the potential H&S risks and impacts and identified control measures.
- A comprehensive plan for reburial and/or in situ protection of the widely scattered burial sites will be developed in consultation with affected families, religious leadership, and the broader community. Pertinent rules such as Proclamation No. 209/2000, Article 7 generally address immoveable cultural heritage, but provide no specific procedural guidelines for mitigation of impacts to immovable cultural heritage.
- Relocation of human remains from disperse location on family landholdings into existing common burial grounds (cemeteries) as mitigation could be negotiated individually with the families of the deceased and
- Area churches. As there is no Mosque is in the area, the single identified Muslim burial site would be handled uniquely to the Christian and traditional burial sites
- Another mitigation alternative is to protect the burial sites in situ. This alternative offers the best protection against impacts from the Project, but is not practical due to the potential for widespread presence of human remains throughout the Project area hindering construction and mining activities
- A third recommended mitigation alternative is to relocate only those human remains buried in the immediately threatened by the development of specific and crucial Project activities or infrastructures.

Wherever possible, burial sites can be kept under enclosures or clearly demarcated to distinguish them from the existing natural landscape. This approach would be particularly useful since many burial sites are in village areas which may remain significantly undisturbed

8.12. Cumulative Impacts

Cumulative impacts are possible effects brought on by the TKGM Project's influence in addition to current or expected future initiatives or activities. Both additive and synergistic interactions can occur between cumulative effects in time and space, where the aggregate of the individual impacts is greater than the sum of the individual impacts. According to the EIA Proclamation (299/2002), an examination of cumulative impacts is necessary since these effects are cumulative and may not be visible when evaluating the individual activities separately.

The cumulative assessment focuses on known planned and foreseeable future development within the project Woreda; and investigates whether any of these planned projects will cause additional unanticipated environmental and social impacts (positive or negative) when combined with the TKGM Project. Activities or projects that are already occurring are effectively included within the baseline assessed as part of the EIA process.

8.12.1. Mining and/or Large-Scale Infrastructure

The TKGP is the first large scale mining project in the western region of Ethiopia. The cumulative impact assessment is the analysis of all effects on an area from one or larger scale infrastructure and/or industrial activities as they accumulate over space and time. When this ESIA started, there were no known commercial or industrial projects planned in the West Wollega Zonal region. Cumulative impacts associated with other projects are therefore not applicable.

Due to the remote location of the TKGP, no cumulative impacts from other development activities are likely to occur in this area. While mining exploration licences are adjacent to and near the proposed Project site (Figure 2-1), none of those exploration licences have invested in detailed geological investigations and are therefore believed to be early exploration or speculative licences. No cumulative impacts from other mining activities are therefore likely to occur in this area.

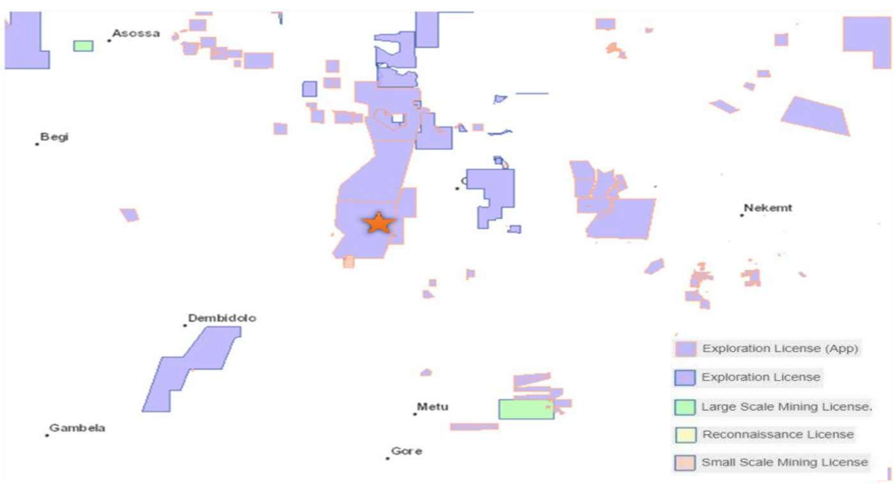

Figure 8-13: Mining licences surrounding the TKGP (location shown by a star) (MoMP, 2020)

8.12.2. Access Road

The primary access road for the TKGP will be the new Keley to Tulu Kapi access road. The road will be unpaved, 6 m in width, and approximately 14.2 km in length. The proposed alignment of the road is shown in 8-11. Under an agreement with the MOFEC, this new access road will be designed and constructed by the Ethiopian Roads Authority.

While TKGM will not be directly responsible for the design and construction of the road, it is being built by the Ethiopian Roads Authority specifically to service the TKGP and is therefore deemed to be associated infrastructure. The impacts associated with the construction of the road therefore need to be considered in this ESIA.

The construction of the new access road will result in the relocation of approximately 12 structures (homes/buildings)[9] in addition to the 286 households located within the MLA that will be resettled with the development of the TKGP. The construction of the new access road will also result in the loss of agricultural land and forest/coffee plantations in addition to the loss of agricultural land and forest/coffee plantations within the MLA.

The significance of this cumulative impact is likely to be low due to the limited number of structures and agricultural land/forest/coffee plantations that will be affected by the construction of the new access road, and provided that the resettlement (including compensation) is undertaken by the Ethiopian Roads Authority in accordance with the relevant Ethiopian legislation. Furthermore, the construction of the new access road will require the relocation of fewer structures than the alternative, which is the upgrading of the existing access road (see Section 2.8).

Note that at the time that this ESIA was being updated, the Ethiopian Roads Authority had not provided TKGM, despite several requests, with any information on the potential impacts associated with the construction of the new access road or the measures that will be implemented to mitigate the potential impacts. It is therefore strongly recommended that once this information is made available, that TKGM review the information provided against the requirements of the relevant Ethiopian legislation, IFC's Performance Standards, and the Equator Principles to identify any potential gaps and to ensure that there is alignment. Furthermore, TKGM should review the information provided against the requirements of their own plans to ensure that there is alignment and consistency in the way in which the potential impacts are being mitigated.

9 Based on survey undertaken in 2011/2012

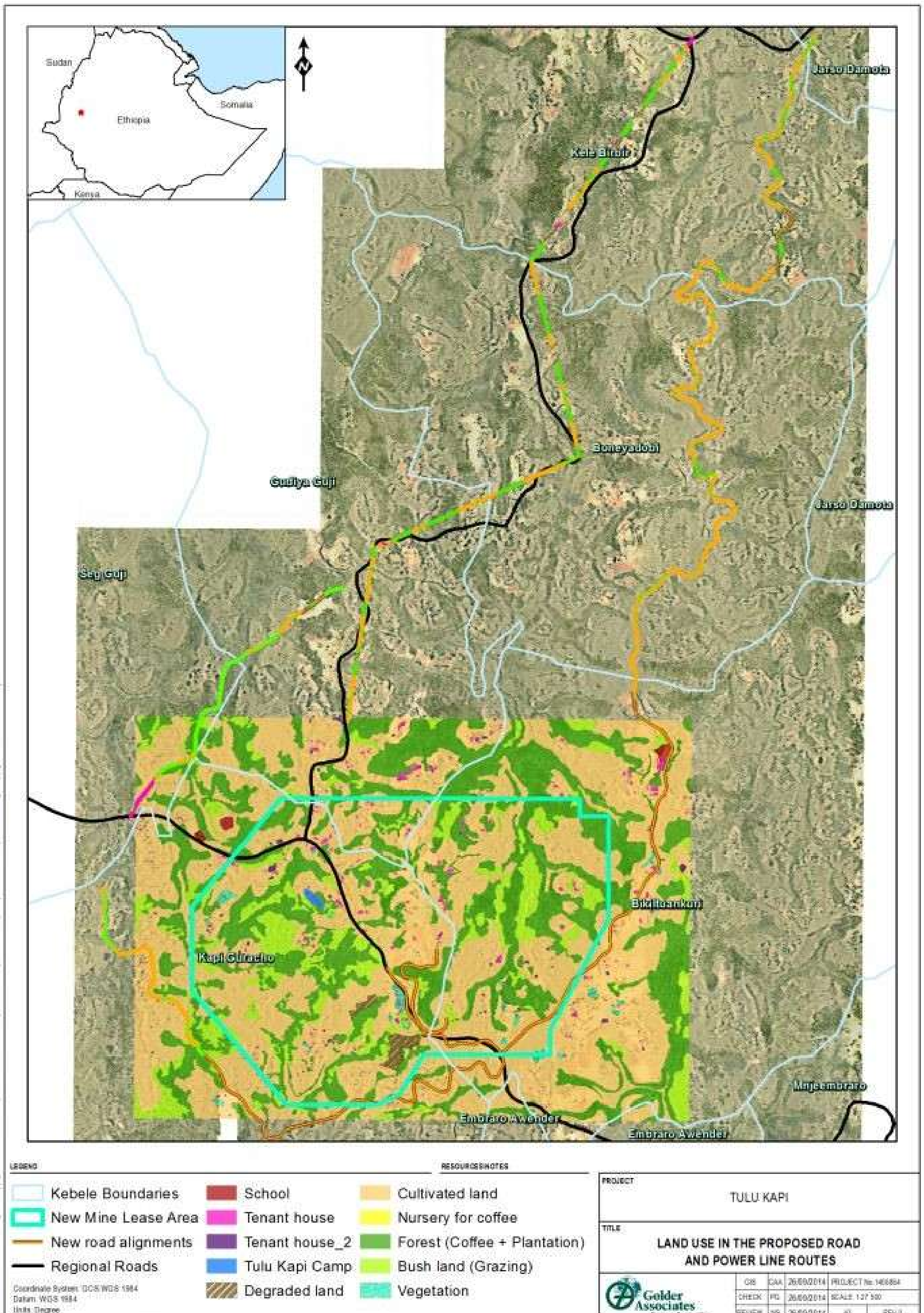

Figure 8-14: Landover within the servitude of the proposed Keley to Tulu Kapi access road and transmission line

8.12.3. Transmission Line

The supply of bulk electricity to the TKGP will be from the EEPCo electricity supply grid. Under an agreement with the MOFEC, the EEPCo will be responsible for the design and construction of approximately 47 km of 132 kV, 15 MVA minimum rated, transmission line on steel, lattice towers, from the Gimbi substation to the new 132/33kV Tulu Kapi substation.

This assessment has considered the potential impacts associated with the construction of the proposed transmission line from Keley to the Tulu Kapi Substation. The construction of this section of the transmission line, which will have an 18 wide servitude, will result in the relocation of approximately 36 structures[10] (Figure 102) in addition to the 286 households located within the MLA that will be resettled with the development of the TKGP. The construction of this section of the transmission line will also result in the loss of agricultural land (~11.1 ha), degraded land (~2.8 ha), forest/coffee plantations (~11.6 ha), and settlements/structures (~0.6 ha) (Figure 101).

Note that at the time that this ESIA was being updated, the EEPCo had not provided TKGM, despite several requests, with any information on the other section of proposed transmission line from Gimbi to Keley, including the potential impacts associated with the construction of the proposed transmission line or the measures that will be implemented to mitigate the potential impacts. As such, the cumulative impacts of the entire length of the proposed transmission line could not be determined. It is therefore strongly recommended that once this information is made available, that TKGM review the information provided against the requirements of the relevant Ethiopian legislation, IFC's Performance Standards, and the Equator Principles to identify any potential gaps and to ensure that there is alignment. Furthermore, TKGM should review the information provided against the requirements of their own plans to ensure that there is alignment and consistency in the way in which the potential impacts are being mitigated. It is also recommended that this ESIA is updated to include the cumulative impact of the entire length of the transmission line when the requested information becomes available.

10 Based on survey undertaken in 2011/2012

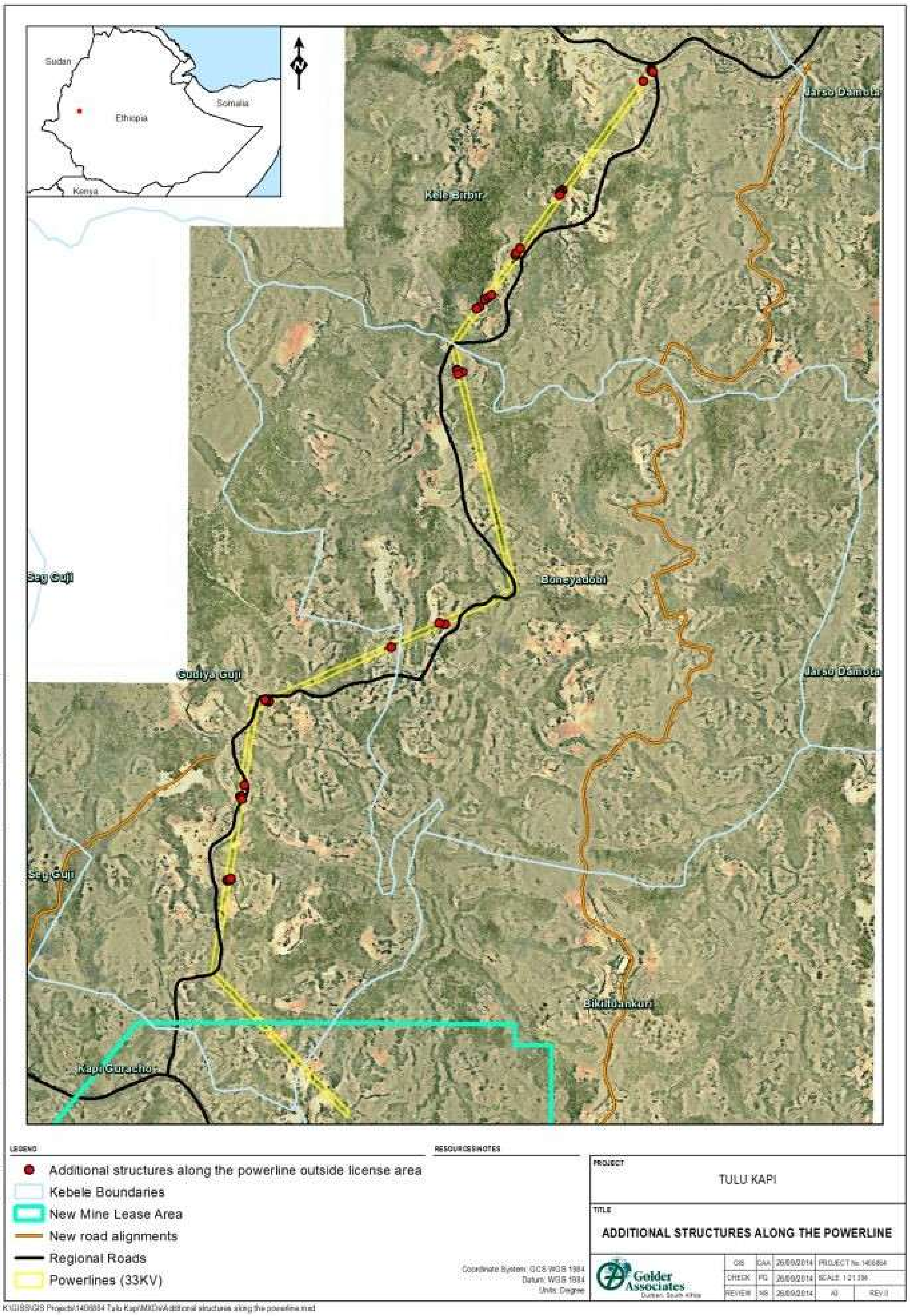

Figure 8-15: Structures affected by the proposed transmission line route

9. ENVIRONMENTAL AND SOCIAL MANAGEMENT

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

The ESMP is comprised of a series of individual plans that outline the scope of environmental, social and health management pertaining to compliance with applicable regulatory requirements. It translates the findings and recommendations of the ESIA into clear measures for the management and monitoring of impacts during the three project phases. Where potential impacts of moderate or higher significance were identified by the ESIA specialists, mitigation measures were recommended to avoid or reduce the impact, if negative, or enhance the impact if positive.

The ESMP is considered as a live document and will need to be regularly updated during the course of the Project’s life in response to the different phases of the Project’s development, regulatory requirements and ongoing monitoring and review of the effectiveness of the plans.

TKGM will develop and implement an environmental management system (“EMS”) to a recognised standard in accordance with their environmental policies to ensure the management of environmental impacts caused by the Project and operations are continually monitored and improved. The EMS will address operational phase, construction and closure phases and will be in place prior to construction starting. It must accommodate the stipulations contained in the relevant environmental laws and regulations of Ethiopia.

9.1. Purpose of the ESMP

The ESIA process identifies the key environmental and social issues, impacts, and risks associated with the project. The ESMP identifies the necessary actions required to manage them. The ESMP serves as a mechanism for implementing the commitments and mitigations identified in the ESIA. It helps to avoid or reduce the potential impacts of the project and outlines the monitoring or record-keeping that will be implemented to ensure the effectiveness of the mitigation measures. The ESMP also provides a tool for auditing the implementation of the ESMP and communicates the management strategy and the project commitments and obligations to stakeholders.

In general TKGM would like to attain the following during the mining development and operation:

- Minimize emission to air
- Implement climate change management
- Minimise the visual impact of operations.
- Minimise disturbance to soil resources.
- Minimise disturbance to native vegetation and native fauna.
- Avoid disturbance to sites of cultural and heritage significance.
- Avoid the introduction or spread of exotic species and implement control measures as necessary.
- Minimise disturbance to drainage patterns and avoid contamination of surface waters and shallow groundwater resources.
- Prevent or minimize the Project's negative social and environmental effects while maximizing its beneficial effects.
- Acknowledge that environmental protection and social responsibility are among the top company goals.
- Optimise (in order of most to least preferable) waste avoidance, reduction, reuse, recycling, treatment and disposal.
- Rehabilitate operational areas as necessary.
- Therefore ESMP will try to address these targets with the following objectives::
    - Facilitate compliance with applicable acts, regulations, and guidelines
    - identify the set of responses to potentially adverse impacts
    - determine requirements for ensuring that those responses are made effectively and in a timely manner

- Describe the means for meeting those requirements.
- Avoid and/or minimise social and environmental negative impacts of the Project and maximise positive impacts
- Recognise that social responsibility and environmental management are among the highest corporate priorities
- Assign clear accountability and responsibility for environmental protection and social responsibility to management and employees
- Facilitate environmental and social planning through project life cycle
- Provide a process for achieving targeted performance levels
- Provide appropriate and enough resources, including training, to achieve targeted environmental performance levels on an on-going basis
- Evaluate environmental performance and social responsibility against TKGM's environmental and social policies, objectives, and targets and seek improvement where appropriate

9.2. Environmental management process

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

Environmental management is the overall strategy followed by management in environmental matters. In practice it aims minimising the environmental impact of the company's processes, products and services, but it also means finding business opportunities in correct environmental behaviour.

One way to work within a company is to implement a standard environmental management Plan. The overall aim of this environmental management Plan is to improve TKGM's environmental performance. The program provides a tool with which to assess the environmental impact of operations. An Environment and Social Management Plan (ESMP) is a tool for managing the impacts of an organization's activities on the environment. It provides a structured approach to planning and implementing environment protection measures.

S Environmental has reviewed and updated the 2020 ESMP that was produced by Golder African Limited.

The aim of this environmental management plan is to provide TKGM with a summary of the key areas that need to be addressed, provide a detailed ESMP, and to provide a detailed environmental monitoring plan.

The key components of this ESMP include preparation of proposed policy statement, establishing environmental programs, designing and creating an environmental management system as well as an auditing system. Other elements of the ESMP include nominating key staff and allocating specific areas of responsibility, defining and establishing an organisational structure, undertaking review of legislation, establish the necessary training and establishing procedures for document control and monitoring.

9.3. ESMP Implementation

9.3.1. Organizational environmental management bodies

In this section of the text, senior staff members or function(s) with adequate authority, expertise, and resources have been suggested as recipients of basic environmental obligations by TS Environmental

Technology. Each functional department should specify the roles and duties of the pertinent individuals based on this standard document, and they should be held accountable for the successful implementation of the ESMP and environmental performance. Employees at all levels should be held responsible for environmental performance within the parameters of their duties in order to support the overall environmental management plan.

Additionally, TS Environmental Technology advises TKGM to hire an ESG manager to oversee the regular evaluation of the overall effectiveness of the ESMP.

TKGM has pledged to offer the tools necessary for the management and execution of the ESMP. These resources include qualified personnel and specific abilities. The environmental and social management duties and obligations of Project personnel, including contractors and other people operating on the company's behalf, shall be defined, documented, and communicated by TKGM. Personnel with particular roles and responsibilities will be given the power to carry out these duties and will be held accountable for doing so.

Table 9.1 lists the essential roles needed to implement the ESMP. These functions need to be examined and added to the organizational structures for the different Project phases. The senior environmental management professional's direct reporting to the senior manager on-site (the General Manager) is a crucial need.

Table 9-1: Summary of responsibilities for implementing the ESMP within the organization

ENVIRONMENTAL ASSIGNMENT	FUNCTION
▪ Over all environmental responsibility for the site. ▪ Endorse the environmental and social management policy and require it to be communicated to the public. ▪ Establish overall direction.	▪ CEO/ General Manager
▪ Developing environmental policy ▪ Establish and maintain a governance system	▪ General manager
▪ Developing environmental objectives, targets and environmental management programme.	▪ Relevant Managers (ESG manager; department managers and managers will set goals and programmes for their department)
▪ Monitoring overall ESMP performance	▪ ESG manager or can be sub contracted to an environmental contractor
▪ Implementation and maintenance of environmental management plan ▪ Ensure regular compliance.	▪ ESG advisor or can be sub contracted to an environmental contractor
▪ Ensure continual improvement.	▪ All managers.
▪ Company environmental report.	▪ ESG manager or can be sub contracted to an environmental contractor
▪ Specific areas (fire safety, electric safety, explosive and chemical safety …etc monitoring)	▪ ESG advisor or can be sub contracted to an environmental contractor
▪ Internal environmental audits.	▪ All managers
▪ Collection of public view	▪ PR /HR officer or can be sub contracted to an environmental contractor.
▪ Training and development	▪ Training manager/EHS advisor or can be sub contracted to an environmental contractor.
▪ Develop and Maintain accounting procedures for cost accumulation and documentation	▪ Financial service.

1.1.2 Operational control

Operations and processes that have been determined to have a major negative impact on the environment should be planned so that they are carried out in a specific way. In order to enable the area to be operated appropriately while not being supervised, including the monitoring and control of the operations, this should be documented in work instructions or operating procedures.

The project's environmental, social, and health issues are covered by the EMP during the mobilization and decommissioning stages. These plans will include information on the mitigation strategies as well as useful advice for managing the risks and repercussions to the environment, society, and health.

The preceding plans are proposed, although their titles and content may be modified and new plans added as the EMP progresses.

1) Occupational Safety and Health
2) Pollution Prevention and Control Plan.
3) Waste Management Plan.
4) Contingency Plan: Unforeseen Events and Emergency Response.

These plans will be presented in the preceding tables; they will state the mitigation measures and other requirements identified through the ESIA. Some of these can be considered to be standard practice measures i.e. they are generally accepted and implemented.

9.3.2. Training and Competency Development

All employees and contractors will receive training on the contents and requirements of the ESMP. An environmental and social awareness plan will be developed by TKGM, prior to commencement each phase of the proposed Project. The plan shall address the following items:

- Basic workforce environmental and social awareness
- Environmental/social sensitivities of the site and surrounding community
- No-go areas such as environmental preservation areas
- Personnel environmental and social training needs
- Resources available for use during personnel environmental and social awareness training

The implementation of the environmental and social training program at the TKGP will be the primary responsibility of the health, environment, safety and security department.
In implementing its environmental training program TKGM will:

- Summarise its environmental training program in a training manual for employees, contractors, and visitors
- Develop a site environmental awareness program for its employees, contractors and visitors that addresses hazard recognition, environmentally sensitive areas, general emergency notification and
- evacuation procedures, and their general responsibilities pursuant to this ESMP
- Provide site environmental awareness training to its employees and contractors prior to the commencement of their work on site and on an ongoing basis throughout the year; its visitors at the time
- of their first visit and annually thereafter
- Provide training on social and cultural aspects including the code of conduct and the chance find procedures
- Develop specific training for its employees and contractors involved in the following activities:
    - Emergency preparedness and response
    - Air resources management
    - Noise and vibration management
    - Water resources management
    - Hazardous and non-hazardous waste management
    - Transportation, handling, and storage of cyanide, chemicals, and fuels
    - Flora and fauna resources management
    - Land and soil resources management
    - Health and safety management
    - Closure and post-closure management

- Ensure that key environmental considerations are included in procedures developed by its operating departments
- Evaluate, on an ongoing basis, the effectiveness of its environmental training programs by means of tests, and general inquiries and observations
- Establish annual environmental training goals and report on the same to the Mine Manager
- Annually review its environmental training program and materials to ensure that operational or other changes have not occurred that necessitate their revision

TKGM will supplement training and awareness programmes through the following initiatives:

- Toolbox talks
- Crew talks
- Site directives
- Newsletter
- Site induction programme
- Videos

Table 9-3: Environmental and social management plan during mobilization and site preparation phases

Project activities with environmental significance	Refer	Potential Hazard	Mitigation Measure	Responsibility	Preliminary estimate of cost to implement
• Clearing of strata during construction • Equipment operation and maintenance	WS01-CO	Surface Water Discharges or runoff to surface water affecting water quality	• The plan should address diversion, excavation, handling excavated material and extent of excavations. • Minimise the footprint of disturbance, as far as practicable. • Properly designed culvert crossings to pass the design flood with minimum backwater, shall be constructed at all river/stream crossings. The approaches and exits from the river crossings must be protected to prevent erosion • Erosion protection should be provided upstream and downstream of the crossing to limit the erosion impacts of the crossing. • The water will be used for dust suppression on site, and, if the water quality meets the target water quality standards, then the water can be discharged to the river system in a controlled manner • Storage of new and used oils in bounded areas • No co-handling of reactive liquids or solids • Creation and monitoring of an inventory of chemicals held on site • Storage of hazardous or toxic substances securely and controlled use thereof • Availability and accessibility of HAZOP sheets of all chemicals • Management of topsoil stockpiles as described in the ESMP • Roads need to be maintained and any erosion ditches formed along the road need to be rehabilitated as soon as possible • The main access road should be constructed furthest from aquatic environments • The extent of impact can be minimised in the immediate area surrounding the rivers by ensuring effective management of storm water and return water • The impacts will be mitigated if the riparian zone is kept intact and no activity is allowed within the buffer zones • Use existing access roads • Adapt mining process to ensure continued rehabilitation during operational phase	Contractor's Representative Client's Representative	
• Operation and maintenance of Construction equipment • Material storage	WR02-CO	Surface Water Unplanned spills or discharges to surface water	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Carry out routine infrastructure checks (i.e., structural, procedural and equipment-based checks). • Ensure full containment of areas with high pollution potential (such as vehicle workshop areas and chemical storage areas). • Treat, evaporate or dispose of any polluted water collected in these areas as a hazardous material. • Ensure any hazardous substances are stored with a containment capacity of at least 110%. • Implement standard procedures for the transport, handling and storage of hazardous substances to minimise the risk of accidental spills. • Put in place spill management procedures to minimise likelihood of spills and facilitate prompt response in the event a spill does occur.	•	•

			• Refueling is to take place at the dedicated refueling station, where practicable. • All vehicle and equipment cleaning and maintenance must be undertaken on a concrete surface which drains to an oil water separator. • Maintain an up-to-date register of all chemicals, reagents or hydrocarbons stored or used across the site. • Personnel working with hazardous substances should be trained in the appropriate handling, storage and disposal requirements. • Ensure no chemicals, reagents or hydrocarbons are stored on bare ground. • Ensure chemical storage containers are labelled, and that labels are intact and legible. • Ensure MSDS sheets are provided at the point of storage and that these are intact and legible. • Provide staff awareness training on the potential HSE risks and impacts and identified control measures. • Effective prevention, containment, and remediation of soil and groundwater contamination will be implemented, in specific acidity and heavy metals pollution as presented in other sections of the ESIA • and impacts assessment section • Fuel/oil spills will be collected and treated according the waste management procedures detailed in the ESMP. Vehicles will be properly maintained to prevent spillage. Spill kits will be available on site. • Buffer zones around rivers and wetlands will be established. Runoff water from the waste rock dumps, stockpiles, seepage drains, and contaminated storm water will be channelled into pollution control dams • Regularly inspect of storage areas (i.e., storage containers/tanks and ancillary piping) to ensure they are not leaking or damaged. • Regularly inspect retention facilities/structures (i.e., bunds, spill trays, etc.) to verify their integrity. • Chemically contaminated soil must be removed and disposed of to a preselected safe location and remediation measures implemented.		
• Clearing of strata during construction • Operation and maintenance construction equipment	WS01-CO	Groundwater Groundwater Levels and Quality	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Compaction of the waste rock and concurrent rehabilitation will minimise ARD risks and limit infiltration and runoff from the WRDs. • A system of gravel drains provided below the compacted clay liner at the valley bottom of the TSF basin will intercept groundwater from springs and to provide dry working surface for the construction of the compacted clay liner. • Water collected by the under-drain system will be conveyed to a sump equipped with a pump, which will be located downstream of the TSF main dam. • The potential for ARD from the WRDs is limited, according to static geochemical testing, but to reduce the risk, a natural clay liner will be engineered on a test cell beneath the first WRD while ARD potential of seepage is confirmed in the field. • One of the important design elements is to maintain the drainage from the WRDs and drainage from the adjacent catchments as two separate water streams.	•	•

			• Ongoing kinetic testing will show water quality and validate water quality is sufficient prior to any environmental discharge. It is advised to provide treatment for the rainfall runoff from the WRDs in the form of sedimentation ponds. • Carry out hydrogeological test work to more precisely determine the hydraulic characteristics in the mining sites. • Provide an alternative water source if project-related effects on village drinking water supplies are discovered. • Create a conceptual and numerical model based on test results for the mine areas to reassess potential effects. • As much as possible, reduce the volume that is abstracted during construction. • Keep the site's water balance in check.		
• Clearing of strata during construction equipment	WS01-CO	Soil Disturbance of Soil and Erosion	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Minimise the footprint of disturbance, as far as practicable. • Scalping (removal) of the upper layer of soil material prior to site disturbance from the TSF, waste rock dumps and processing plant areas should be in place. The scalped soil will be stockpiled, demarcated, and protected for rehabilitation reuse. • Rehabilitate disturbed areas concurrently with operations where possible. • Restrict use of vehicles/equipment to demarcated areas to prevent unnecessary expansion of the footprint of disturbance. • Inspect disturbed, rehabilitated and sensitive areas such as riverbanks affected by project infrastructure for visual signs of erosion and/or deposition. If problems are identified, initiate remedial action. • Carry out regular inspections for visual signs of erosion and implement appropriate remedial actions. • Provide staff awareness training on the potential HSEC risks and impacts and identified control measures.	•	•
• Clearing of strata during construction • Operation and maintenance construction equipment	SL02-CO	Soil Soil Contamination	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Excessive soil contamination by fuel or oil spills will be collected to be treated • Vehicles will be maintained regularly and kept in a good working order. • Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. Vehicles and mine machinery will be operational mostly along haulage roads and within specific areas, thus confining any pollutants to specific areas. • Fuel and oil tanks and dispensing areas will be isolated to capture any spills. Vehicle servicing, repairs and washing will be in isolated, controlled areas. Workshops will have hard floors and sumps to capture any fugitive oils and greases. • It is proposed that the TSF be designed with a clay liner and cover with a breaker layer which should significantly limit contamination once proven.	•	•

Land and vegetation clearance	BD01-C)	Biodiversity Habitat Loss and Fragmentation	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Minimise the footprint of disturbance, as far as practicable. • Restrict use of vehicles/equipment to demarcated areas to prevent unnecessary expansion of the footprint of disturbance. • Limit land clearance within sensitive and ecologically important features as far as practicable (i.e., 'non fixed' components, such as lay down areas, temporary crossings etc.). • Disturbed areas will be graded and re-vegetated as quickly as possible, and plants and trees of conservation importance will be replanted. • Soils contaminated by spills will be collected and treated according the waste management procedures detailed in the ESMP. • Minimise disturbance to wetland habitat outside the direct footprint by clearly demarcating the construction areas and limiting all activities to these areas. • Offset enhancement of wetlands downstream of the TSF will be conducted to maintain ecological function. This may be conducted by such activities as planting, irrigation, natural and artificial contouring of lands, exclusion of cattle, and restoration of drainages to more natural physical shapes. • Dust suppression will be used on unpaved roads, disturbed, or excavated surfaces, and loading sites. • The proposed water supply pipeline should follow and be placed as close to the Keley-Tulu Kapi road as possible • Topsoil stripped during construction should be stockpiled and used to rehabilitate disturbed areas • A suitable rehabilitation programme should be developed and implemented in all disturbed areas. The programme should include active re-vegetation, using locally occurring indigenous grass and tree species • Areas that should be considered priority sites for stabilisation and rehabilitation post-construction, should they be negatively impacted, include: first and second order stream crossings; the BirBir River, and any vegetated areas along the pipeline route that may not be already impacted (i.e. coffee). • An Alien Invasive Species Control Programme must be developed and implemented	•	•
• Clearing of strata during construction • Operation and maintenance construction equipment	BD02-CO	Biodiversity Changes in surface water flows affecting Ecological Receptors	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Footprint will be minimized through clear demarcation, disturbed areas will be graded and re-vegetated as quickly as possible, and plants and trees of conservation importance will be replanted. • Soils contaminated by spills will be collected and treated according the waste management procedures detailed in the ESMP. • Where possible, maintain buffer zones around riverine forest habitat. • Minimise surface disturbance/activities within this buffer zone as far as practicable • Install crossings perpendicular to the bank, where practicable. • Avoid crossings on potentially unstable section of the channel (i.e., bends).	•	•

			• Minimise disturbance to wetland habitat outside the direct footprint by clearly demarcating the construction areas and limiting all activities to these areas. • Regularly inspect road crossings after high water events. • Provide staff awareness training on the potential HSEC risks and impacts and identified control measures.		
• Clearing of strata during construction • Operation and maintenance construction equipment	BD03-03	Biodiversity Habitat Alteration - Increased Colonisation by Exotic Species and Introduction of AIS	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Footprint will be minimized through clear demarcation, disturbed areas will be graded and re-vegetated as quickly as possible, and plants and trees of conservation importance will be replanted. • An Alien Invasive Species Control Programme must be developed and implemented at both temporary construction sites and permanent operational sites. The programme must include: • The use of both mechanical and chemical control treatments, as required ○ Provision for periodic follow-up treatments ○ Regular monitoring ○ The implementation of the programme should be overseen by an ECO officer during construction, and the SHEQ or Environmental Manager during the operational phase ○ Fences (or other suitable obstacle/deterrent) should be erected to prevent fauna gaining access to construction areas, such as open trenches ○ The handling, hunting, poisoning, and/or killing of onsite fauna by construction workers and contractors must be strictly prohibited ○ General noise abatement equipment should be fitted to machinery (i.e. genset) and vehicles • Strip and store soils in an appropriate manner during construction so that they can be used in rehabilitation activities once construction is completed. Management will ensure no compaction occurs or alien invasive colonise the stored materials • Clean vehicles and loads entering the Project area and reduce traffic volumes to prevent invasive plant species from colonizing the area	•	•
Investment decision leading a large amount of money in the local and national economy	SE01-CO	Socioeconomic Increased Government Revenue and Capital Infusion	• Follow EITI guidelines when it comes to the publication of data on payments made to the government. • Establish and preserve positive connections with regional and national regulatory organizations that encourage and support high standards of accountability and openness for tax and royalty payments.	•	•
Project infrastructure Construction activity	SE02-CO	Socioeconomic Direct Employment Generation	• Develop and implement a Recruitment Management Plan that addresses: ○ Preferential hiring from the neighborhood, whenever possible. ○ Includes a corporate interpretation of local. ○ Procedures for revealing job openings and skill criteria. ○ Procedures for identifying and choosing workers that are fair, open, and transparent (i.e., to minimize the possibility of nepotism, recruitment fees, etc.).	•	•

			○ Methods for educating and advancing local employees with the goal of maximizing local content in positions requiring semi-skilled and skilled labor. • Particularly marginalized or disadvantaged groups in the key local • Maintain an employee database including information on the employee's background, position, hours worked, training received, and pay and benefits. • Provide appropriate preliminary vocational training programmes within the local primary sphere to boost skills and increase access to potential direct, indirect or induced employment opportunities.		
• Project infrastructure Construction activity	SE03-CO	Socioeconomic Indirect and Induced Employment Generation	• Create and implement a procurement plan that takes into account: • Create and distribute a procurement policy that specifies the general strategy for organizing, administering, and sourcing procurement activities. ○ Prioritisation of procurement from the local area. ○ Incorporates a corporate definition of local. ○ Processes for identification of procurement needs, along with a commitment to consider unbundling selected contracts to provide opportunities for smaller businesses to provide goods and services. ○ Processes for identification and selection of suppliers/contractors/consultants, ensuring it is undertaken in a fair, open and transparent manner. ○ Mechanisms to enhance procurement of goods and services from the primary local sphere, such as the purchase of goods from the local markets, early payment of suppliers (to improve cash flow), etc. ○ Mechanisms to enhance procurement of goods and services from vulnerable or marginalised groups within the primary local sphere. ○ Mechanisms to limit in-migration. ○ Mechanisms to ensure contractor activities are consistent with the objectives of the plan. • Develop and maintain a database of relevant local vendors/businesses and their potential capacity to provide goods and services locally. EncoLurage them to participate in bids. • Identify, track and record key project-related benefits generated including the recipients of the benefits and timeframes over which these were received. • Collaborate with authorities and other development projects in the region for potential skills development and training programmes.	•	•
• Project infrastructure Construction activity	SE04-CO	Socioeconomic Influx of Population	• Develop and disseminate a Procurement Policy that outlines the overall approach to planning, sourcing and managing procurement activities. • Develop and implement a Procurement Plan that addresses: ○ Prioritization of procurement from the local area. ○ Incorporates a corporate definition of local. ○ Processes for identification of procurement needs, along with a commitment to consider unbundling selected contracts to provide opportunities for smaller businesses to provide goods and services. ○ Processes for identification and selection of suppliers/contractors/consultants, ensuring it is undertaken in a fair, open and transparent manner.	•	•

			○ Mechanisms to enhance procurement of goods and services from the primary local sphere, such as the purchase of goods from the local markets, early payment of suppliers (to improve cash flow), etc. ○ Mechanisms to enhance procurement of goods and services from vulnerable or marginalised groups within the primary local sphere. ○ Mechanisms to limit in-migration. ○ Mechanisms to ensure contractor activities are consistent with the objectives of the plan. • Develop and maintain a database of relevant local vendors/businesses and their potential capacity to provide goods and services locally. Encourage them to participate in bids. • Identify, track and record key project-related benefits generated including the recipients of the benefits and timeframes over which these were received. • Collaborate with authorities and other development projects in the region for potential skills development and training programmes		
• Project infrastructure Construction activity	SE05-CO	Socioeconomic Physical and Economic Displacement	• Develop and implement a resettlement action plan (RAP) for land acquisition and compensation in accordance with the resettlement policy framework • Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Minimise land take, as far as practicable • Layout of the project should be improved to reduce land acquisition and relocation of habitations and productive areas. • Ensure that displaced assets, such as structures, are compensated. • Offer compensation for the loss of productive land, including agricultural land replacement, the creation of improved agricultural prospects through irrigation, fertilization, the promotion of agricultural techniqu, and other measures as outlined in the RAP. • Promote the creation and implementation of community development and livelihood restoration initiatives, particularly those that emphasize the preservation and improvement of existing livelihood practices. • These coffee plants may need to be reestablished over the course of five years, during which time households will need to be supported. • Monitoring and mitigation of post-compensation should continue. • Create a social map of the stakeholders who are both directly and indirectly impacted, highlighting, for instance, the sphere of influence and connections between various stakeholder groups. The stakeholder engagement plan ("SEP") will contain social mapping, which will be updated yearly. • Establishing a grievance redress mechanism; • Facilitate the provision of replacement or new crops to those affected by land take. • Investigate the vulnerability of households with respect to changes in livelihood strategies. • Facilitate development and implementation of livelihood restoration and community development programs, especially those that focus on restoring market and subsistence agriculture.# Facilitate development of alternative, non-	•	•

			land-based livelihoods through training, inputs and access to markets, especially where options for restoration of land-based livelihoods are limited. • Undertake ongoing monitoring and mitigation of residual impacts. • On-going resource findings suggest the LOM will extend to at least 20 years. Infrastructure is being built to accommodate a 20-year LOM project.		
• Project infrastructure Construction activity	SE06-CO	Socioeconomic Increased Pressure on Existing Ecosystem Services	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Minimise land take, as far as practicable. • Develop and implement a resettlement action plan (RAP) for land acquisition and compensation in accordance with the resettlement policy framewor • Any clearing of natural forests will be done in accordance with the Forestry Conservation Development and Utilisation Proclamation No 94/1994. • Refine the Project layout to minimize the impact on land and natural resources. • The local population's reliance upon aquatic and terrestrial biodiversity will be documented in the RAP and appropriate mitigation measures refined as needed. • Provide "in-kind" compensation for the loss of land and natural resources on which the local communities are reliant to the extent possible. • Extended baseline work should be done to determine households' dependence on ecosystem services and natural resources during the RAP implementation. In addition, investigations should be undertaken to determine affected households' willingness and interest in changing their livelihood strategies and encourage those households to alternative resettlement options.	•	•

• Project infrastructure Construction activity	SE07-CO	Socioeconomic
		Safety and Security Risks
			• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms.
			• Provide staff awareness training on the potential HSEC risks and impacts and identified control measures.
			• Prior to start of construction, TKGM will facilitate a health impact assessment which will inform its approach to both employee and community health and safety management. This health impact assessment will need to establish a baseline for community health (especially related to communicable diseases and sexually transmitted disease ("STDs")).
			• Prior to start of construction, TKGM will also facilitate completion of a Community Health and Safety Plan in collaboration with the Ministry of Health to address future populations of employees and their support networks.
			• The Health and Safety Management Plan ("HSMP") will be refined to ensure that it addresses all factors identified in the Traffic Impact Assessment, mine development plan, and ESIA. In addition, TKGM will:
			    o Continue implementation of its health and safety policy and adaptively manage changes as needed
			    o Continue training for all employees, contractors and subcontractors in the company health and safety requirements
			• Develop a detailed Emergency Preparedness and Response Plan ("EPRP")
			• Communities and employees will need to be made aware of the potential dangers and emergencies that could result from mining activities and infrastructure
				•	•

			• TKGM's mine plan incorporates potential development of a new access road (as one of the alternatives), thus allowing exclusion of pedestrian and vehicular traffic, while maintaining existing pedestrian traffic along the existing route to Keley. • TKGM will develop, disclose, adopt and implement a community health and safety plan which will include traffic and transportation risk management.		
• Project infrastructure Construction activity	SC01-CO	Social and Cultural Cohesion Increased Marginalisation of Vulnerable Groups	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Create and put into effect a management and monitoring plan for the environment and society that focuses on potential effects and related impact mechanisms. • Identify, track, and keep a record of the major project-related benefits that were produced, as well as who received them and when. • To keep track of prospective rises in products and services, establish and implement a food price monitoring system (i.e., for a typical consumer basket of items). • Actively support programs that expand possibilities for women to make decisions for themselves, earn more money, and possibly have better futures. • Conduct routine evaluations of the perceived difficulties and alterations in the quality of life in the communities impacted by the project.	•	•
• Project infrastructure Construction activity	CHS01-CO	Community Health and Safety Increased Disease Prevalence within Employees and Communities	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Foster an education and awareness program aimed at addressing anti-social behaviors (such as substance abuse and violence) in collaboration with pertinent partners, local leaders, and the woreda/kebele authorities. • Assist NGOs and the local health department in enhancing their initiatives to combat infectious diseases. • Work with NGOs and the government of the woreda administration to develop policies for HIV/AIDS, TB, and other potentially contagious diseases with an emphasis on prevention, control, diagnosis, and treatment. • Work with relevant partners, local leaders and the woreda/ kebele authorities to promote an education and awareness programme targeted at managing anti-social behaviours (i.e., substance abuse, violence). • As part of the Emergency Response Plan, establish suitable communication channels with local and regional health organizations as well as leaders of potentially affected communities. This will cover the unlikely scenario of an infectious disease outbreak at the mine site or in the nearby towns. • Keep an eye out for the appearance of significant pandemics via WHO alerts, and when necessary, put the Emergency Response Plan into action. • Require contractors to comply with the company's health-related policies and programmes. • TKGM will support a health impact evaluation that will shape its approach to both employee and community health and safety management. • TKGM will require contractors to comply with the company's health-related policies and programs.	•	•

			• To address future populations of workers and their support networks, TKGM will promote the creation of a Community Health and Safety Plan in partnership with the Ministry of Health		
• Project infrastructure Construction activity	CHS02-CO	Creation of Permanent Surface Water Feature Increasing Malaria	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Implement an Integrated Malaria Control, Prevention and Treatment Programme that focuses on vector management, individual risk management, and limiting the effects of infection. • Avoid the creation of mosquito breeding conditions through proactive surface water management during construction and operational activities. • Collaborate with the local authorities to minimise development of settlements close to the WDs. • Wherever possible, burial sites can be kept under enclosures or clearly demarcated to distinguish them from the existing natural landscape. This approach would be particularly useful since many burial sites are in village areas which may remain significantly undisturbed	•	•

9.3.3. ESMP during operation phase

Table 9-4: Environmental and social management plan during mobilization and site preparation phases

Project activities with environmental significance	Refer	Potential Hazard	Mitigation Measure	Responsibility	Preliminary estimate of cost to implement
• Mining and processing operations which include pit dewatering, TSF spill, runoff from the ROM pad and Ore Processing Plant and waste rock dumps.	WS01-OP	Surface Water Discharges or runoff to surface water affecting water quality	▪ Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. ▪ A systematic water monitoring programme should be developed and implemented. ▪ All clean stormwater around the proposed TSF should be diverted away. All stormwater generated within the footprint of the TSF should be controlled and internally managed ▪ Ensuring appropriate lining of the TSF with a layer of low permeable material (e.g. saprolite) ▪ Reduction in the pool size to minimise seepage rates ▪ Construction of sediment control ponds downstream of the WRDs to catch runoff from the WRDs ▪ Installing an under-drainage system above the lining to minimize the head imposed on it and, thereby, reducing seepage potential ▪ Installing groundwater-monitoring wells down gradient of the TSF ▪ Storage facilities for the stormwater should take account of the run-off qualities and have appropriate engineered barriers in place to prevent unacceptable downstream water resource impacts. Such measures to reduce impacts may include, but not be limited to: reduction in the pool size to minimise seepage rates; active or passive water treatment (e.g., wetland); retention and use in the mine water circuit; retention and controlled release; and groundwater interception mechanisms (e.g. interception boreholes, trenches, reactive barriers) ▪ A database of water quality monitoring results should be developed to help identify long term trends in water quality. ▪ TKGM shall develop and implement a thorough plan for the treatment and release of water from the settling dams to the environment ▪ Construct field cells next to the WRDs filled with various waste rock materials and monitored for infiltration, drainage quality and drainage volume during the operational phase of the mine. This will provide invaluable site specific kinetic geochemical data that will be required for the prediction of post closure water qualities as a function of closure rehabilitation measures ▪ Intercept pit groundwater seepage before it enters the pits by dewatering boreholes. This will prevent contamination of the groundwater and can potentially be discharged directly to environment ▪ Prior to commencement of Phase 4, the water balance model which has been calibrated using collected data, must be updated to include the north mining pit	Contractor's Representative Client's Representative	

• Mining and processing operations which include surface water diversion, water intake from the river and emergency and failure of TSF	WS02-OP	Surface water
		Altered surface water flow regimes
			• Develop and implement an Environmental and Social Management, and Monitoring Plan to target the potential impacts and associated impact mechanisms.
			• TKGM will ensure that it develops and implements a water resources management plan that addresses water withdrawal and/or retainment and utilisation, and discharges, as a minimum.
			• Conduct a detailed dam break consequence assessment on the WD and TSF.
			• Minimise the footprint of disturbance, as far as practicable.
			• Water balance modelling is an on-going process and can be used to modify management and mitigation measures, based on updated flow and level monitoring.
			• Review annual water consumption data to identify data to identify opportunities for reduced water usage across the site.
			• Establish targets for reducing water consumption.
			• Direct surface runoff unaffected by operation around project facilities to existing natural drainage lines.
			• Install the designed sediment control structures downstream of the infrastructure to maximise capture of sediment on the license.
			• Undertake regular inspections of surface water management infrastructure (i.e., diversion channels, trenches, culverts etc.) to ensure functionality as intended.
			• Design road drains to reduce runoff flow rates and volumes, providing flow attenuation where necessary.
			• Avoid creation of drop-offs and scour pools downstream of culverts.
			• Carry out routine infrastructure checks (i.e., structural, procedural, and equipment-based checks).
			• The pumping protocol at the end of the rainy season from September to mid-November at a rate of 55 ℓ/s should be followed, however it is proposed that river flows are monitored before and during the abstraction period to confirm that the reduction in flow is in fact negligible.
			• A systematic water monitoring programme should be developed and implemented
			  • The monitoring network should incorporate evaluation of the mine water system. It is recommended that the main focus is placed on:
			  • The water levels in the various dams
			  • Pit pumping
			  • The monitoring of the barge return water from the TSF
			  • Plant water intake and use.
			  • Water balance modelling is an on-going process and can be used to modify management and mitigation measures, based on updated flow and level monitoring.
			  • Conduct hydrological, hydrogeological, and geochemical modelling to determine the long-term pit lake water quality and water balance
			• TKGM shall incorporate the evaluation of the mine water system in the overall monitoring network. The focus shall be placed on:
			  • The water levels in the various dams
			  • Pit pumping
			  • The monitoring of the barge return water from the TSF
				•	•

• Wate rock disposal	WR03-OP	Surface water Seepage from mining waste which include AMD	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • A waste material handling strategy should be formulated as part of the operating procedures for the WRDs as well as captured in an ARD management plan for the site. This strategy should be updated regularly based on results from the on-going kinetic tests • In order to effectively manage the contamination plume from the TSF, a contamination system which consists of a trench and interception boreholes is proposed (GPT, 2020).	•	•

			• Construct rock blanket underdrainage systems to collect water seeping through the waste rock and to direct the seepage to the sediment control ponds • Undertake further geochemical characterization of the tailings and waste rock to confirm the low risk of acid rock drainage and metal leaching. • On-going kinetic testing will indicate water quality and confirm water quality is sufficient prior to any environmental release. • Stormwater containment and clean and dirty water should be separated. • All stormwater generated within the footprint of the TSF should be controlled and internally managed. Where possible, place the acid generating altered waste rock (albitised syenite and quartz vein in the centre part of the WRDs or in a similar fashion be encapsulated with as much non-PAG waste rock material (ultramafic silicates syenite and diorite/basic dyke)		
• Support and service functions which include storage of chemicals, Oil and equipment maintenance	WR04-OP	Surface water Unplanned spills or discharges to surface water	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Carry out routine infrastructure checks (i.e., structural, procedural and equipment-based checks). • Ensure full containment of areas with high pollution potential (such as vehicle workshop areas and chemical storage areas). • Treat, evaporate or dispose of any polluted water collected in these areas as a hazardous material. • Ensure any hazardous substances are stored with a containment capacity of at least 110%. • Implement standard procedures for the transport, handling and storage of hazardous substances to minimise the risk of accidental spills. • Put in place spill management procedures to minimise likelihood of spills and facilitate prompt response in the event a spill does occur. • Refueling is to take place at the dedicated refueling station, where practicable. • All vehicle and equipment cleaning and maintenance must be undertaken on a concrete surface which drains to an oil water separator. • Maintain an up-to-date register of all chemicals, reagents or hydrocarbons stored or used across the site. • Personnel working with hazardous substances should be trained in the appropriate handling, storage and disposal requirements. • Ensure no chemicals, reagents or hydrocarbons are stored on bare ground. • Ensure chemical storage containers are labelled, and that labels are intact and legible. • Ensure MSDS sheets are provided at the point of storage and that these are intact and legible. • Provide staff awareness training on the potential HSE risks and impacts and identified control measures. • Effective prevention, containment, and remediation of soil and groundwater contamination will be implemented, in specific acidity and heavy metals pollution as presented in other sections of the ESIA and impacts assessment section • Fuel/oil spills will be collected and treated according the waste management procedures detailed in the ESMP. Vehicles will be properly maintained to prevent spillage. Spill kits will be available on site. • Buffer zones around rivers and wetlands will be established. Runoff water from the waste rock dumps, stockpiles, seepage drains, and contaminated stormwater will be channelled into pollution control dams • Regularly inspect of storage areas (i.e., storage containers/tanks and ancillary piping) to ensure they are not leaking or damaged.	•	•

			• Regularly inspect retention facilities/structures (i.e., bunds, spill trays, etc.) to verify their integrity. • Chemically contaminated soil must be removed and disposed of to a preselected safe location and remediation measures implemented.		
• Mining and pit dewatering	GW01-OP	Groundwater Groundwater Levels and Quality	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • A system of gravel drains provided below the compacted clay liner at the valley bottom of the TSF basin will intercept groundwater from springs and to provide dry working surface for the construction of the compacted clay liner. • Water collected by the under-drain system will be conveyed to a sump equipped with a pump, which will be located downstream of the TSF main dam. • Static geochemical tests indicate a low potential for ARD from the WRDs, however, to minimise risk, a natural clay liner will be engineered on a test cell beneath the first of the WRDs while confirming the ARD potential of seepage in the field. On-going kinetic testing will indicate water quality and confirm water quality is sufficient prior to any environmental release. • One of the key design principles is to keep the drainage from the WRDs and drainage from the surrounding catchments as two separate water streams. Provision of treatment in the form of sedimentation ponds for the rainfall runoff from the WRDs is recommended. • Compaction of the waste rock and concurrent rehabilitation will minimise ARD risks and limit infiltration and runoff from the WRDs. • Installing groundwater-monitoring wells down gradient of the TSF o The TSF includes an engineered barrier to reduce seepage to groundwater and the water course downstream. The engineered barrier can take the form of lower permeability materials combined with an under-drain system. The risk of downstream water resource impacts should be considered in defining the competence of the engineered barrier o Intercept pit groundwater seepage before it enters the pits by dewatering boreholes. This will prevent contamination of the groundwater and can potentially be discharged directly to environment o Rebound of the groundwater in the pits is an effective measure to reduce post closure ARD and ML due to the reduction in oxidation rates under a water cover o The post closure pit water quality should be assessed and modelled during the operational phase to refine the requirements for long-term water treatment to prevent downstream groundwater impacts o Continue monitoring shallow aquifers, near the TSF, WRDs and open pits. Monitoring shall continue until an appropriately qualified independent third-party establishes that steady state conditions have been achieved and there is no risk of contamination related to the areas mentioned above..	•	•

• Development of the TSF, waste rock dumps, and processing plant •	SL01-COO	Soil Disturbance of Soil and Erosion	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Minimise the footprint of disturbance, as far as practicable. • Scalping (removal) of the upper layer of soil material prior to site disturbance from the TSF, waste rock dumps and processing plant areas should be in place. The scalped soil will be stockpiled, demarcated, and protected for rehabilitation reuse. • Rehabilitate disturbed areas concurrently with operations where possible. • Restrict use of vehicles/equipment to demarcated areas to prevent unnecessary expansion of the footprint of disturbance. • Inspect disturbed, rehabilitated and sensitive areas such as riverbanks affected by project infrastructure for visual signs of erosion and/or deposition. If problems are identified, initiate remedial action. • Carry out regular inspections for visual signs of erosion and implement appropriate remedial actions. • Provide staff awareness training on the potential HSEC risks and impacts and identified control measures.	•	•
• Mining Operation including waste rock disposal • Spillage from TSF	SL02-COP	Soil Soil Contamination	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Excessive soil contamination by fuel or oil spills will be collected to be treated • Vehicles will be maintained regularly and kept in a good working order. • Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. Vehicles and mine machinery will be operational mostly along haulage roads and within specific areas, thus confining any pollutants to specific areas. • Fuel and oil tanks and dispensing areas will be isolated to capture any spills. Vehicle servicing, repairs and washing will be in isolated, controlled areas. Workshops will have hard floors and sumps to capture any fugitive oils and greases. • It is proposed that the TSF be designed with a clay liner and cover with a breaker layer which should significantly limit contamination once proven.	•	•
• Spillage of Harmful or Toxic Substances operation of the mine and processing • Spillage from equipment maintenance	BD02-OP	Biodiversity Changes in Water Quality Affecting Ecological Receptors	▪ Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. ▪ Footprint will be minimized through clear demarcation, disturbed areas will be graded and re-vegetated as quickly as possible, and plants and trees of conservation importance will be replanted. Where ▪ Possible, local seed collection will be undertaken, and a native plant nursery will be developed and maintained. These efforts will be detailed in a line with a Vegetation Rehabilitation Plan which will be developed and implemented ▪ Soils contaminated by spills will be collected and treated according the waste management procedures detailed in the ESMP. Vehicles will be properly maintained to prevent spillage. All potentially dangerous ▪ Substances will be handled according to international best practice. ▪ TSF will be constructed so as to prevent contaminants migrating into the environment ▪ Maintain cyanide levels in the TSF at levels which are typically non-lethal to wildlife and livestock. In areas where cyanide levels exceed these safe limits, measures such as fencing, filling in collection ▪ ditches with gravel, and covering netting of ponds or impoundments, should be implemented to restrict access wildlife and livestock ▪ Dust suppression will be used on unpaved roads, disturbed, or excavated surfaces, and loading sites. Disturbance will be minimized whenever possible, and construction methods will be selected to minimize	•	•

			▪ Dust generation. Stockpiles and loads of soils or aggregates will also be treated to prevent dust generation (e.g. mulching, covering, moistening, or applying tackifiers where appropriate). Traffic will be restricted to designated routes, and speed limits will be strictly enforced ▪ Open pit areas will be marked and natural barriers to prevent animals entering the area. Culverts and drift fences will be installed, and speed limits strictly enforced along roads to reduce animal mortality		
• Clearing of strata during construction • Operation and maintenance construction equipment	BD02-CO	Biodiversity Changes in surface water flows affecting Ecological Receptors	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Footprint will be minimized through clear demarcation, disturbed areas will be graded and re-vegetated as quickly as possible, and plants and trees of conservation importance will be replanted. • Soils contaminated by spills will be collected and treated according the waste management procedures detailed in the ESMP. • Where possible, maintain buffer zones around riverine forest habitat. • Minimise surface disturbance/activities within this buffer zone as far as practicable • Install crossings perpendicular to the bank, where practicable. • Avoid crossings on potentially unstable section of the channel (i.e., bends). • Minimise disturbance to wetland habitat outside the direct footprint by clearly demarcating the construction areas and limiting all activities to these areas. • Regularly inspect road crossings after high water events. • Provide staff awareness training on the potential HSEC risks and impacts and identified control measures.	•	•
Investment decision leading a large amount of money in the local and national economy	SE01-OP	Socioeconomic Increased Government Revenue and Capital Infusion	• Follow EITI guidelines when it comes to the publication of data on payments made to the government. • Establish and preserve positive connections with regional and national regulatory organizations that encourage and support high standards of accountability and openness for tax and royalty payments.	•	•
• Project infrastructure operation activity	SE02-CO	Socioeconomic Direct Employment Generation	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Develop and disseminate a Recruitment Policy that outlines the overall approach to recruitment activities. • TKGM will develop, disclose, adopt and implement the following management plans to enhance local employment opportunities: ○ Influx Management Plan: to identify and implement measures to manage in-migration, and avoid, prevent, and mitigate the direct and indirect adverse impacts associated with project-induced in-migration ○ Stakeholder Engagement Plan: to ensure that stakeholders, including local residents, are involved in the ESIA of the proposed Tulu Kapi Project	•	•

			○ Recruitment, Training and Local Employment Plan: to identify and implement appropriate procedures for recruiting and training people from the local communities ○ Local Procurement Plan: to identify and implement appropriate procurement practices which engage local businesses in TKGM's supply chain		
• Operation of the mine	SC01-COP	Social and Cultural Cohesion Increased Marginalisation of Vulnerable Groups	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Create and put into effect a management and monitoring plan for the environment and society that focuses on potential effects and related impact mechanisms. • Identify, track, and keep a record of the major project-related benefits that were produced, as well as who received them and when. • To keep track of prospective rises in products and services, establish and implement a food price monitoring system (i.e., for a typical consumer basket of items). • Actively support programs that expand possibilities for women to make decisions for themselves, earn more money, and possibly have better futures. • Conduct routine evaluations of the perceived difficulties and alterations in the quality of life in the communities impacted by the project.	•	•
• Mine operation	CHS01-COP	Community Health and Safety Increased Disease Prevalence within Employees and Communities	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Foster an education and awareness program aimed at addressing anti-social behaviors (such as substance abuse and violence) in collaboration with pertinent partners, local leaders, and the woreda/kebele authorities. • Assist NGOs and the local health department in enhancing their initiatives to combat infectious diseases. • Work with NGOs and the government of the woreda administration to develop policies for HIV/AIDS, TB, and other potentially contagious diseases with an emphasis on prevention, control, diagnosis, and treatment. • Work with relevant partners, local leaders and the woreda/ kebele authorities to promote an education and awareness programme targeted at managing anti-social behaviours (i.e., substance abuse, violence). • As part of the Emergency Response Plan, establish suitable communication channels with local and regional health organizations as well as leaders of potentially affected communities. This will cover the unlikely scenario of an infectious disease outbreak at the mine site or in the nearby towns. • Keep an eye out for the appearance of significant pandemics via WHO alerts, and when necessary, put the Emergency Response Plan into action. • Require contractors to comply with the company's health-related policies and programmes. • TKGM will support a health impact evaluation that will shape its approach to both employee and community health and safety management. • TKGM will require contractors to comply with the company's health-related policies and programs. • To address future populations of workers and their support networks, TKGM will promote the creation of a Community Health and Safety Plan in partnership with the Ministry of Health	•	•

• Mine operation	CHS02-COP	Creation of Permanent Surface Water Feature Increasing Malaria	• Develop and implement an Environmental and Social Management and Monitoring Plan to target the potential impacts and associated impact mechanisms. • Implement an Integrated Malaria Control, Prevention and Treatment Programme that focuses on vector management, individual risk management, and limiting the effects of infection. • Avoid the creation of mosquito breeding conditions through proactive surface water management during construction and operational activities. • Collaborate with the local authorities to minimise development of settlements close to the WDs. • Wherever possible, burial sites can be kept under enclosures or clearly demarcated to distinguish them from the existing natural landscape. This approach would be particularly useful since many burial sites are in village areas which may remain significantly undisturbed	•	•

9.3.4. ESMP Closure phase

Preliminary closure considerations have been assessed during this ESIA review and update process. Based on the preliminary closure objectives, current industry standards, the current project description and the preliminary understanding of conditions at the site, the following initial concepts have been developed for the key Project components. At the time of final closure of the Project, the mine area will be reclaimed to a safe and environmentally sound condition consistent with closure commitments developed during the life of the Project. Of particular significance to the mine closure planning process will be the rehabilitation and remediation of the WRD and TSF, as this will contain the bulk of the mining residues.

Until such time as specific closure objectives are defined, general objectives will be to:

- Maintain worker health and safety throughout closure activities, including concurrent closure;
- Protect public health and safety;
- Demonstrate chemical stability compatible with site conditions;
- Demonstrate physical stability compatible with site conditions;
- Create self-sustaining ecosystem compatible with site conditions;
- Minimise need for reclamation maintenance;
- Minimise negative impact on retrenched employees and local economy;
- Maintain community relations;
- Reduce closure liability during operations through an aggressive concurrent closure program;
- Discuss opportunities surrounding beneficial post-closure uses of project infrastructure with local stakeholders; and
- Where possible, leave behind value of use.

9.3.5. Monitoring Programmes

The HSEC Management Plan will be supported by an appropriate monitoring programme developed to monitor and measure the effectiveness of the management measures implemented across the TKGM Project, as well as to meet any obligations under existing permit conditions.

To meet these objectives, the monitoring programme will detail:

- The monitoring obligations.
- The location coordinates of sampling sites in relation to site infrastructure (including control sites).
- The frequency and duration of sampling.
- The parameters to be monitored.
- The sampling collection, storage, and preservation methodologies to be employed.
- Quality control and assurance measures (i.e., calibration of instruments, data management approaches).
- Reporting requirements and reporting timeframes.

A preliminary environmental monitoring programme has been prepared and is presented in Table 9-. The programme provides a framework of monitoring to evaluate performance and assist in predicting and managing impacts with more detailed to be developed during the detailed design phase prior to project implementation.

The focus and extent of monitoring will be commensurate with the risk of impacts occurring, the sensitivity of the surrounding areas and the local communities' perceptions of risks to their health and environment. These detailed monitoring programme will include the criteria against which the monitoring results will be compared (i.e., thresholds, targets, or baseline conditions) and the actions required if the criteria or thresholds are exceeded.

Monitoring data will be analysed to identify temporal and spatial trends and compliance with relevant criteria. Monitoring reports will be produced to meet internal and external reporting requirements including an annual HSEC report that integrates the reports and assesses long term trends (as required under Element 12 of the HSEC Management System). If monitoring results indicate non-conformance with stipulated thresholds or if a significant deteriorating trend is observed, it will be recorded as a non-conformance and handled by an internal (company) non-conformance and incident procedure developed as part of the ESMS.

To facilitate transparency with stakeholders, third parties may be involved in either collecting or providing the relevant monitoring data. This is likely to involve community monitoring committees and verification of monitoring data by qualified and experienced external experts.

The monitoring programme will be reviewed on a regular basis (at least every two years) and adjusted, where necessary.

Table 9-5:Environmental and Social Monitoring Programme

Aspect	Impact reference.	Type of monitoring	Frequency	Location	Records
Climate		Temperature, wind speed, wind direction, humidity, rainfall, atmospheric pressure.	Continuous.	Existing climate stations.	
		Electricity usage (quantity).	Quarterly.	Site wide.	
air quality		Particulates ($PM_{10/2.5}$).	Monthly.	Fixed stations upwind/downwind of the site. Roving stations to address specific issues.	
		Dust fallout.	Monthly.	Fixed stations upwind/downwind of the site.	
		Ambient NO_2 and SO_2.	Quarterly.		
Noise and Viberation		Noise levels (LA_{eq}, LA_{10}, LA_{90}).	Monthly.	Various, including on-site and off-site sensitive receptor locations.	
		Noise Spectrum analysis.	Annually, including day and night readings.	Various, including on-site and off-site sensitive receptor locations.	
		Vibration (in transverse, radial and vertical directions) and noise.	During blasts.	Various, including on-site and off-site sensitive receptor locations	
Water resources		Dewatered volumes.	Daily.	Open pits.	
		Static groundwater level.	Monthly.	On-site and off-site locations.	
		Water consumption.	Quarterly.	Site wide.	
		Surface water flows.	Continuous throughout wet season; bi-weekly download.	Existing downstream monitoring sites.	
		Water quality (groundwater and surface water).	Bi-monthly. Key parameters only, with full-suite	Various, including on-site and off-site sensitive receptor locations.	

Aspect	Impact reference.	Type of monitoring	Frequency	Location	Records
			analysis on an annual basis or if required on a risk basis		
Soil		Extent of disturbed and rehabilitated areas.	Monthly during construction. Quarterly during operations.	Site wide.	
		Extent of disturbed areas outside of site footprint.	Quarterly.	Site wide.	
		Visual inspection for signs of erosion.		Site wide.	
				Site wide.	
Groundwater					
Biodiversity					
		Fishing activity within water supply dam.	Monthly.		
		Migratory bird passage (numbers and timing).	Annual.		
		Situational biodiversity.	Bi-annually		
		Records of animal and bird kills	Monthly.		
Mine wastes		Quantity of mineral waste per year and cumulative total.	Quarterly.	Site wide.	
		Water quality (groundwater and surface water) to enable early detection and management of ARDML if it occurs.	Quarterly.	Downstream/downgradient of pits, WRDs, TSF, stockpiles.	
Non-mining waste		Quantity and type of waste generated per year (including cumulative total) and management strategy (i.e., reuse, recycle, treat, or dispose).	Quarterly.	Site wide.	
Use of chemicals, reagents, hydrocarbons		Fuel usage (quantity).	Quarterly.	Site wide.	
		Register of all chemicals, reagents or hydrocarbons purchased, delivered, stored, and used on-site.	Quarterly.	Site wide.	

Aspect	Impact reference.	Type of monitoring	Frequency	Location	Records
		Visual inspections of retention facilities/ structures (i.e., bunds, spill trays) to verify integrity.	Daily.	All main workplaces.	
Traffic		Speed limits monitored using vehicle tracking systems.	Continuous monitoring.	Site wide.	
Jobs		Register of applicants and actual employees, including origin of employee, position, working hours, training received, wages/ benefits.		Site wide.	
		Register of vendors/ businesses engaged to provide services, including origin of contractors.		Site wide.	
		Register of employees training received.		Site wide.	
Livelihoods		Food price monitoring (i.e., for a typical consumer basket of goods).		Within project area of influence.	
		Regular assessments of the perceived challenges and changes to quality of life.		Within project area of influence.	
		Livelihood restoration monitoring.	Bi-yearly for two years (until a completion audit has confirmed acceptability of restored livelihoods).	Within project area of influence.	
		Initiatives and ventures for promotion of alternative livelihoods (including participation of vulnerable groups in these)	Yearly	Within project area of influence.	Reports on initiatives.
Population influx		Population and rate of growth.	Every 2 years.	Within project area of influence.	
		Presence of informal settlements.	Quarterly during construction. Annually during operations.	Within project area of influence.	

10. CONCLUSIONS

TKGM proposed to develop the Tula Kapi Gold Project, which involves two open pits, processing plant, three mine waste disposal facilities, water supply dam, and ancillary infrastructure and services within the vicinity of the mine (such as accommodation and access roads) required to support the project activities.

The TKGP is located in the Highlands of Western Ethiopia, in Oromia Regional State and in the Genji Woreda administrative district, approximately 360 km due west of the capital, Addis Ababa.

The TKGP is accessible by the main paved road from Addis Ababa, a distance of 520 km with the final 15 km by means of an all-weather unpaved road running through surrounding villages. Chartered aircraft from Addis Ababa may land at the Project's unregistered grass airstrip at Ayra, approximately 30 km from the Project site, whilst Ethiopian Airlines operate scheduled flights every day to Assosa airport, a 5-hour drive from the Project site.

An ESIA process has been undertaken in accordance with Ethiopian requirements, specifically the Proclamation No. 299/2002, while considering good international industry practice. The report provides a detailed description of the existing biophysical and socio-economic conditions of the project area, assessment of impacts (including cumulative impacts) and identification of appropriate management measures to mitigate negative impacts or enhance positive impacts.

The assessment of impacts considers the proposed design and implementation of the project in the context of the existing baseline conditions and is based on outcome of predictive modelling studies (for some components), input received through a comprehensive stakeholder consultation process, and the experience of the ESIA team of other mining projects in Ethiopia and internationally.

A summary of the potential impacts is provided in table 8-1 , which includes the initial and residual significance ratings and confidence rating of the assessment. It is noted that measures to avoid or reduce impacts inherent to the project design (i.e., in the siting of infrastructure or inclusion of abatement equipment) and as such are not considered in the initial impact rating. The residual impact rating assumes the management measures described in the previous chapters to ameliorate or compensate the impact have been implemented.

The negative impacts can be grouped into categories as follows:

- **Negative impacts with management measures that require monitoring**: this group incorporates impacts initially of medium to high significance that reduce following implementation of management measures, however, monitoring of the effectiveness of the management measures is required to enable early identification and implementation of additional measures if required. This group includes economic displacement of people and their livelihoods, increase pressure on infrastructure and services, water availability, air quality, and malaria prevalence.
- **Negative impacts with standard management measures**: this group incorporates the remaining residual impacts of low to medium significance, due to the nature of the impact or that it can be appropriately managed by measures that are not difficult to implement and are known to be reliable.

Positive impacts represent the main benefits created by the project, which are expected to be significant at all levels (local, regional, and national). These benefits include increased direct and indirect government revenue, employment opportunities, stimulation of local economic growth (increased demand for goods and services), training and skills development, and enhanced investment into a programme for community development, which will contribute to poverty alleviation in Ethiopia.

Table 10.1: initial and residual impact ratings

ID #	Topic	Ref. code	Potential impacts discussed	Significant rating	
				Initial impact	Residuals impact
1	Air Quality	AR01	Increased air emission	Moderate	Low
2	Climate	CC01	Increased greenhouse gas emissions	Moderate	Low
3	Noise	NO01	Increased Noise level	Moderate	Low
4	Surface water	WR01	Discharges or runoff to surface water affecting water quality	High	Moderate
		WR02	Altered surface water flow regimes	High	Moderate
		WR03	Seepage from mining wastes	Moderate	Low
		WR05	Unplanned spills or discharges affecting water quality	Moderate	Low
5	Groundwater		Groundwater level and quality	Moderate	Low
6	Soils and land capability	SL01	Disturbance of Soil and Erosion	High	Moderate
		SL02	Soil Contamination Due to Leaching of Soluble Chemical Pollutants	High	Moderate
7	Biodiversity	BD01	Habitat loss and fragmentation	Moderate	Moderate
		BD02	Changes in surface water flows affecting Ecological Receptors	Moderate	Low
		BD03	Habitat Alteration - Increased Colonisation by Exotic Species and Introduction of AIS	Moderate	Low
		BD04	Habitat alteration – attractive nuisance and alien invasive species	Moderate	Low
8	Economy and Employment	EE01	Increased government revenue and capital infusion	Positive	Positive
		EE02	Direct employment generation	Positive	Positive
		EE03	Indirect and induced employment generation	Positive	Positive
		EE04	Influx of Population	Moderate	Moderate
		EE05	Physical and Economic Displacement	High	Moderate
		EE06	Increased Pressure on Existing Ecosystem Services	Low	Low
		EE07	Safety and security	Moderate	Low

The overall conclusion of this EIA is that most potential negative impacts identified can be reduced to acceptable levels with effective management measures, which TKGM is committed to implementing. TKGM's commitment to effective management is highlighted by the work undertaken to date to avoid or mitigate many impacts as far as practicable through the appropriate consideration of alternatives and subsequent project design. There are several management controls requiring interaction with either Government officials or potentially affected communities, in particular the resettlement action plan. TKGM is committed to ensuring this process is undertaken equitably, whilst appropriate stakeholder engagement is undertaken with the potentially affected communities. These management measures form the basis of the ESMP,

The final phase of the ESIA process is regulatory review. As part of this process, this document will be made available to interested stakeholders in accordance with the Stakeholder Engagement Plan (Appendix). Feedback received during this process will be provided to the regulatory authorities.

11. REFERENCES

11.1. General ESIA

G&A Opex Rev0A 2014-04-16, received via email from Kefi Minerals
Golder (2015). Tulu Kapi North, West, and South Mine Waste Dump Design Report. Report No. 1417458. Golder Associates Africa.
GPT (2020). Hydrogeological Desk Study Report for the Tulu Kapi Tailings Storage Facility. GPT Consulting Environmental Scientists.
International Finance Corporation (2007), Environmental, Health, and Safety (EHS) Guidelines; GENERAL EHS GUIDELINES.
JEMA Consulting International and SRK (2011), Environmental and Social Impact Assessment for the Tulu Kapi Gold Mine. As submitted to Ministry of Mines Ethiopia on 11 May 2011
KCB (2020). TSF Preliminary Hydrogeochemical Assessment. Klohn Crippen Berger.
KEFI (2020). Tulu Kapi DFS. https://www.kefi-minerals.com/projects/ethiopia/tulu-kapi/dfs [accessed 24 August 2020]
Knight Piésold (2020a). Preliminary Design Report for the Tulu Kapi Tailings Storage Facility and Water Storage Dams. Project No. RI402-00012/10 (Rev: A)
Knight Piésold (2020b). Commissioning Water Balance Model. File Ref. No. PE402-00012/11-A bas M20001
Lycopodium (2020). Process Design Criteria. Report No. 2121-FPDC-001. Lycopodium Minerals Pty Ltd
Lycopodium (2017). Tulu Kapi Gold Project Study Update. Report No. 1953-000-GEREP-0001. Lycopodium Minerals Pty Ltd
MoMP (2020). Ethiopian Mining Cadastre Portal. Ministry of Mine and Petroleum. www. ethiopian.portal.miningcadastre.com [accessed on 30 September 2020]
Snowden (2015), KEFI Minerals plc: Tulu Kapi Mining Feasibility Study, 150617 Draft AU4556 KEFI Tulu Kapi Mining FS from MACE_RevC.docx. Snowden Mining Industry Consultants
TKGM (2020). Water Supply to Project: Birbir River Pipeline - Technical Details. Technical Memorandum. Doc No: TKGM/MEMO/AK/0023
TKGM (2020). Resettlement Action Plan. Tulu Kapi Gold Mine.
TKGM (undated). Stakeholder Engagement Plan. Tulu Kapi Gold Mine.
Updated Mining Schedule – Source EPOCH, via email from KEFI Minerals.
Updated site environmental data from the KEFI weather station, via email from KEFI Minerals.
Updated Labour Schedule SS0562, received via email from KEFI Minerals.
Updated SENET Overall Flow sheet received via email from KEFI Minerals.
Updated GIS shapefiles of the proposed project (version 22 September 2014), received via email from KEFI Minerals.
http://www.kefi-minerals.com/projects/ethiopia/tulu-kapi/dfs.

11.2. Air Quality

Australian National Pollutant Inventory, Emission Estimation Technique Manual for Gold Ore Processing, Version 2.0, December 2006.
Australian National Pollutant Inventory, Emission Estimation Technique Manual for Mining, Version 3.1, January 2012.
Chestnut, L.G. *et al.,* 1991: Pulmonary Function and Ambient Particulate Matter: Epidemiological Evidence from NHANES I, Archives of Environmental Health, 46, 135 – 144, 1991.
Colls, J. (2002): Air Pollution, second edition, Taylor and Francis, New York.
EPA (Environmental Protection Agency), 2019: Health Effects of Exposures to Mercury https://www.epa.gov/mercury/health-effects-exposures-mercury.
Fenger, J., 2002: Urban air quality, In J. Austin, P. Brimblecombe and W. Sturges (eds.), Air pollution science for the 21st century, Elsevier, Oxford, 2002
Harrison, R.M. and R.E. van Grieken, 1998: Atmospheric Aerosols. John Wiley: Great Britain, 1998.
Hough, H. (2012): What is the Best Dust Control Product for Roads? Miners News, February / March 2012, 150, A-9. Available online at: http://www.minersnews.com/FebMar2012/MinersNews150-FebMar2012-SectA.pdf.
IFC, 2007. Environmental, Health, and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality. World Bank Group, International Finance Corporation.
Katestone Environmental (2011): NSW Coal Mining Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining, Report compiled on behalf of NSW Office of Environment and Heritage.
Ker, A. D. R., Moorse, M. W., Watts, E. R., & Gill, B. N. (1978). *Agriculture in East Africa. An introduction to principles and practices*. Edward Arnold, London, UK.

Kissell, F. N. (2003): Handbook for Dust Control in Mining. Available online at: http://www.cdc.gov/niosh/nas/rdrp/appendices/chapter3/a3-23.pdf.
Lan, Q., Zhang, L., Li, G., Vermeulen, R., Weinberg, R.S., Dosemeci, M., Rappaport, S.M., Shen, M., Alter, B.P., Wu, Y. and Kopp, W., 2004: Hematotoxicity in workers exposed to low levels of benzene. *Science*, *306*(5702), pp.1774-1776.
Manahan, S.E., 1991: Environmental Chemistry, Lewis Publishers Inc, United States of America.
NEM: AQA, 2013: National dust control regulations. Republic of South Africa, National Environmental Management: Air Quality Act 39 of 2004, Government Gazette no, 36974, November 2013.
Pope, C. A III and Dockery, D.W., 1992: Acute Health Effects of PM_{10} Pollution on Symptomatic and Non-Symptomatic Children, American Review of Respiratory Disease, 145, 1123–1128.
Pope, C. A. III and Kanner, R.E., 1993: Acute Effects of PM_{10} Pollution on Pulmonary Function of Smokers with Mild to Moderate Chronic Obstructive Pulmonary Disease, American Review of Respiratory Disease, 147, 36–40.
Preston-Whyte, R.A and Tyson, PD, 1988. The Atmosphere and Weather of Southern Africa. Oxford University Press.
Rubel, F., & Kottek, M., 2010: Observed and projected climate shifts 1901–2100 depicted by world maps of the Köppen-Geiger climate classification. *Meteorologische Zeitschrift*, *19*(2), 135-141.
Tyson, P.D. and Preston-Whyte, R.A. (2000): The Weather and Climate of Southern Africa, Oxford University Press, Southern Africa, 285 – 304.
United Nations Environment Programme, Addis Ababa City Air Quality Policy and Regulatory Situational Analysis, 2018.
USEPA., 1995: Compilation of air pollutant emission factors, AP-42, Fifth Edition Volume 1: Chapter 13: Miscellaneous Sources - Introduction to Fugitive Dust Sources, U.S Environmental Protection Agency, Research Triangle Park, N.C.
World Bank Group, 2007. Environmental, Health and Safety Guidelines - Mining
World Health Organization, 2000: WHO Air Quality Guidelines for Europe, 2nd edition. WHO Regional Office for Europe, Copenhagen, Denmark. WHO Regional Publications, European Series, No 91).
World Health Organization., 2005: WHO Air Quality Guidelines Global Update. WHO Regional Office for Europe, Copenhagen, Denmark.

11.3. Climate Change and Greenhouse Gas Emissions

IPCC (2014). Climate Change 2014: Synthesis Report. Intergovernmental Panel on Climate Change (IPCC). Geneva, Switzerland
World Bank (2020). Climate Change Knowledge Portal. https://climateknowledgeportal.worldbank.org/region/africa/climate-data-historical [accessed on 21 May 2020]

11.4. Culture and Heritage

Ahmad, Abdussamad H. (1999), “Trading in Slaves in Bela-Shangul and Gumuz, Ethiopia: Border Enclaves in history, 1897-1938” The Journal of African History, Vol. 40, and No.3:433-446.
Burka, Temesgen (2008), “The Socio-cultural aspects of furnace shape, decorations: Iron smelting activities among the Oromo of West Wollega, Ethiopia” in Nyame Akuma, N. 69, June 2008. pp.1-9.
Burka, Temesgen. (2009), “Why the Tumtuu are Not Marginalized: New Perspectives on the Positions of the Smiths in Western Ethiopia, Wollega” in Nyame Akuma, N.72. December 2009. pp.12- 20.
Burka, Temesgen. (2011), ‘The Archaeology of iron production in Ethiopia: Ethnoarchaeometallurgical case studies from Wollega’. PhD dissertation (unpublished), University of Naples L’Orientale.
Central Statistical Agency of Ethiopia (2012), <http://www.csa.gov.et/>.
Cerulli, E. (1933), Etiopia Occidentale: Dallo Scio Alla Frontiera Del Sudan. Volume Secondo, Sindacato Italiano Arti Grafiche, Rome, 1933-XI.
Gidada, Negaso. (2001), History of the Sayyo-Oromo of southwestern Wollega, Ethiopia from about 1730-1886. Frankfurt am Main.
Hamrla, M. (1966), “The Iron and Manganese Ore Deposits in Ethioèia” in Geologija, 9:439-487.
Hassen, Mohammed. (1990), The Oromo of Ethiopia: A History, 1570-1860. Cambridge University Press.
Mining-Technology.com (2012), <http://www.mining-technology.com/projects/tulu-kapi-gold-project/>
Ministry of Youth, Sports, and Culture. (2012), http://www.mysc.gov.et/ARCCH.html
NyotaMinerals.com. (2012), <http://www.NYOTAminerals.com/index.php>
Triulzi, Alessandro. (1981), Salt, Gold and Legitimacy: Prelude to the history of a no-man’s land Bela Shangul, Wallaga, Ethiopia (ca. 1800-1898). Napoli, IUO.
Triulzi, Alessandro. (1975), “Trade, Islam, and the Mahdia in northwestern Wallaga” in The Journal of African History, Vol. 16, No.1.
Wolde-Mariam, Mesfin (1972), An Introductory Geography of Ethiopia. Berhanena Selam H.S.I. Printing Press, Addis Ababa.

11.5. Acid Drainage / Geochemistry

AMMTEC (2011) Quantitative Automated Mineralogical Analysis Conducted on Three (3) 500 µm Head

Samples for Nyota Minerals Limited. AMMTEC Limited, Project A12931, Mineralogy report number MIN639, January 2011.
Ashley RP (2002) Geoenvironmental Model for Low-Sulfide Gold-Quartz Vein Deposits. In: Seal RR and Foley NK (eds) Progress on Geoenvironmental Models for Selected Mineral Deposit Types. United States Geological Survey (USGS) Open File Report 02-195, 2002.
Golder (2013) Tulu Kapi Gold Project Long Term Acid Potential and Metal Leaching Assessment Report. Golder Associates Africa (Pty) Ltd, Report No. 12614051-12012-3, April 2013.
Golder (2012) Tulu Kapi Gold Project Mine Infrastructure Geotechnical Report. Golder Associates Africa (Pty) Ltd, Report No. 11613370, 9 May 2012.
JEMA (2011) Environmental and Social Impact Assessment for the Tulu Kapi Gold Mine. JEMA International Consulting PLC and SRK Consulting (South Africa) (Pty) Ltd, April 2011.
Nyota (2010) Further Metallurgical Test Results from Tulu Kapi. Nyota Minerals Limited, 4 October 2010.
Price, WA (2009) Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. Mine Environment Neutral Drainage (MEND) Report 1.20.1, December 2009.
Seal RR, Foley NK and Wanty RB (2002) Introduction to Geoenvironmental Models of Mineral Deposits. In: Seal RR and Foley NK (eds) Progress on Geoenvironmental Models for Selected Mineral Deposit Types. United States Geological Survey (USGS) Open File Report 02-195, 2002.
Smith KS and Huyck HLO (1999) An Overview of the Abundance, Relative Mobility, Bioavailability, and Human Toxicity of Metals. In: GS Plumlee and MJ Logsdon (Eds.) The Environmental Geochemistry of Mineral Deposits, Reviews in Economic Geology Volume 6A, pp 29-70.
SRK (2010) Geochemical samples. SRK Consulting (South Africa), memo from James Lake to Channa Pelpola dated 21 October 2010 (no reference).
SRK (2011), A Mineralogy Appendix for the ARDML Study on the Tulu Kapi Project, Ethiopia. SRK Consulting (UK) Limited, Report UK4403, August 2011.
Wardell (2011), Nyota Minerals Limited – Tulu Kapi Mineral Resource Estimation. Wardell Armstrong International, Report No. MM597, September 2011.

11.6. Terrestrial Ecological

AASHTO. (2002), Roadside Design Guide, 3rd Ed. Washington, DC: American Association of State and Highway Transportation Officials.
Angold, P. (1997), The impact of a road upon adjacent heathland vegetation: Effects on plant species composition. Journal of Applied Ecology, 34 (2): 409-417.
Bråkenhielm, S., & Qinghong, L. (1995), Impact of sulphur and nitrogen deposition on plant species assemblages in natural vegetation. Water, Air, & Soil Pollution 85 (3): 1581-1586.
Brodziewska, J. (2005), Wildlife tunnels and fauna bridges in Poland: past, present and future, 1997-2013. UC Davis: Road Ecology Center.
Brumm, H. (2004), The impact of environmental noise on song amplitude in a territorial bird. Journal of Animal Ecology, 73:434–440.
Canaday, C., & Rivadeneyra, J. (2001), Initial effects of a petroleum operation on Amazonian birds: Terrestrial insectivores retreat. Biodiversity and Conservation, 10:567–595.
Farmer, A. (1993), The effects of dusts on vegetation – a review. Environmental Pollution, 79: 63-75.
Forman, R., & Alexander, L. E. (1998), Roads and Their Major Ecological Effects. Annual Review of Ecology and Systematics, 29: 207.
Irwin, R., VanMouwerik, M., Stevens, L., Seese, M., & Basham, W. (1997), Environmental Contaminants Encyclopedia. Fort Collins, Colorado: National Park Service, Water Resources Division.
JEMA International Consulting plc. (2011), Ecological Baseline Study Assessments for Tulu Kapi Goldmine Project Area. Addis Ababa, Ethiopia: JEMA International Consulting plc.
Walker, D. A., Webber, P. J., Everett, K. R., & Brown, J. (1978), Effects of Crude and Diesel Oil Spills on Plant Communities at Prudhoe Bay, Alaska, and the Derivation of Oil Spill Sensitivity Maps. Arctic, 31 (3): 242-259.

11.7. Aquatic Ecology

Barbour, M., Gerritsen, J., Snyder, B. and Stribling, J. (1999), Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. Washington, DC. Available from: http://www.epa.gov/OWOW/monitoring/techmon.html.
Davies, B. R. and Day, J. A. (1998), Vanishing Waters. University of Cape Town Press. Available from: https://books.google.co.za/books?id=-PBDAQAAIAAJ.
Dickens, C. W. and Graham, P. M. (2002), The South African Scoring System (SASS) Version 5 Rapid Bioassessment Method for Rivers, African Journal of Aquatic Science, 27 (1), pp. 1–10. DOI:10.2989/16085914.2002.9626569.
Gerber, A. and Gabriel, M. (2002), Aquatic Invertebrates of South African Rivers - Illustrations.
Golubtsov, A. S. and Darkov, A. A. (2017), A Review of Fish Diversity in the Main Drainage Systems of Ethiopia Based on the Data Obtained by 2008 OF ETHIOPIA BASED ON THE DATA OBTAINED BY 2008, (March).
Habteselassie, R., Mikschi, E., Ahnelt, H. and Waidbacher, H. (2010), Garra chebera, a new species of

cyprinid fish from an isolated basin in Ethiopia (Teleostei : Cyprinidae), Anna, 111 (January), pp. 43–53.
Hardin, S. and Connor, L. (1992), Variability of electrofishing crew efficiency, and sampling requirements for estimating reliable catch rates, North American Journal of Fisheries Management, 12, pp. 612–617.
Hellawell, J. (1977), Biological Surveillance and Water Quality Monitoring, In: JS Alabaster (Ed). Biological Monitoring of Inland Fisheries. Applied Science, London. Pp 69-88.
Hill, T. D. and Willis, D. W. (1994), Influence of Water Conductivity on Pulsed AC and Pulsed DC Electrofishing Catch Rates for Largemouth Bass, pp. 202–207.
IUCN (2018) The IUCN Red List of Threatened Species, Version 2018-2. DOI:http://dx.doi.org/10.2305/IUCN.UK.2016- 3.RLTS.T22719744A94642482.en.
Kaaya, L. T., Day, J. A. and Dallas, H. F. (2015), Tanzania River Scoring System (TARISS): a macroinvertebrate-based biotic index for rapid bioassessment of rivers, African Journal of Aquatic Science, 40 (2), pp. 109–117. DOI:10.2989/16085914.2015.1051941.
Kennedy, G. J. A. and Strange, C. D. (1981), Efficiency of Electric Fishing for Salmonids in Relation to River Width, Aquaculture Research. DOI:10.1111/j.1365-2109.1981.tb00010.x.
McMillan, P. (1998), An Invertebrate Habitat Assessment System (IHAS, version 2) for the Rapid Biological Assessment of Rivers and Streams, A CSIR Research Project, Number ENV-P-I 98132 for the Water Resources Management Programme, CSIR, ii, pp. 44.
Nelson, K. L. and Little, A. E. (1987), Increasing the effectiveness of electrofishing boats in low conductivity waters, Proceedings of the Annual Conference South-eastern Association of Fish and Wildlife Agencies, 41, pp. 230–236.
Plafkin, J. L., Barbour, M. T., Porter, K. D., Gross, S. K. and Hughes, R. M. (1989), Rapid Bio-assessment protocols for use in streams and rivers: benthic macroinvertebrates and fish, U.S. Environmental Protection Agency.
Pusey, B. J., Kennard, M. J., Arthur, J. M. and Arthington, A. H. (1998), Quantitative sampling of stream fish assemblages: Single- vs multiple-pass electrofishing, Austral Ecology, 23 (4), pp. 365–374. DOI:10.1111/j.1442-9993.1998.tb00741.x.
Regis, J., Pattee, E. and Lebreton, J. (1981), A new method for evaluating the efficiency of electric fishing, Archiv Für Hydrobiologie, (93), pp. 68–82.
Reynolds, J. (1983), Electrofishing, American Fisheries Society, Bethesda, Maryland, pp. 147–163.
Stiassny, M. L. J. and Getahun, A. (2007), An overview of labeonin relationships and the phylogenetic placement of the Afro-Asian genus Garra Hamilton, 1922 (Teleostei: Cyprinidae), with the description of five new species of Garra from Ethiopia, and a key to all African species, Zoological Journal of the Linnean Society, 150 (1), pp. 41–83. DOI:10.1111/j.1096-3642.2007.00281.x.
Tadlo, A. M. (2015), Fish Species Diversity in Major River Basins of Ethiopia: A Review, World Journal of Fish and Marine Sciences, 7 (5), pp. 365–374. DOI:10.5829/idosi.wjfms.2015.7.5.95195.
Tarboton, W. R. and Tarboton, M. (2002), A Field guide to the Dragonflies of South Africa. Warwick & Michèle Tarboton. Available from: https://books.google.co.za/books?id=jk0gAQAAIAAJ.
Thirion, C. A., Mocke, A. and Woest, R. (1995), Biological monitoring of streams and rivers using SASS4. A User's Manual, Internal Report No.N 000/00REQ/1195. Institute for Water Quality Studies. Department of Water Affairs and Forestry. Department of Water Affairs and Forestry, Pretoria, South Africa.
USGS (2004), Methods for Sampling Fish Communities as part of the National Water-Quality Assessment Program. Available from: http://water.usgs.gov/nawqa/protocols/OFR-93-104/fishp1.html [Accessed.
Zalewski, M. (1985), The estimate of fish density and biomass in rivers based on relationships between specimen size and efficiency of electrofishing, Fisheries Research. DOI:10.1016/0165-7836(85)90015-3.

11.8. Noise and Vibration

Acoustics. http://hyperphysics.phy-astr.gsu.edu/hbase/acoustic/invsqs.html.
African Minerals Limited, Stage 1 Environmental, Social and Health Impact Assessment, WorleyParsons, June 10, 2010.
Anon3, (2010), Goodquarry. http://www.goodquarry.com Accessed 12 October 2010;
Botteldooren, D., B. De Coensel & T. De Muer (2006), The temporal structure of urban soundscapes. Journal of sound and vibration, 292, 105 -123.
Consultnet.ie. http.//www.consultnet.ie/environmental.
De Jager M. (2010), Noise impact study for environmental impact assessment.
Field survey (2012), Noise impact assessment at mine in Rustenburg by B v/d Merwe.
Garvin, T., T.K. McGee, K.E. Snoyer – Tonic & E.A. Aubyn. (2008), Community - company relations in gold mining in Ghana. Journal of Environmental Management, 90, 571 – 586.
Good Quarry (2006), http://www.goodquarry.
International Finance Corporation Environmental Health and Safety Guidelines for Mining, December 10, (2007).
Kim, D & S Lee S. (2000), Propagation and attenuation characteristics of various ground vibrations. Soil Dynamics and Earthquake Engineering. 19 115 – 126.
Massarch, K.R. (1993), Manmade vibrations and solutions. Proceedings of the Third International Conference on case histories in Geo technical engineering, 1393 – 405.

SANS 10210 of 2004 – Calculating and predicting road traffic noise, ICS17.140.30; 43.020. ISBN 0 -626-16011-1.
Tonkilili Iron Ore Project ESHIA – Writers Instruction Guide, Report 13032, January 18, 2011;
United States Department of Interior, Bureau of Reclamation – State water research control board;
United States of Bureau - Mine Standards, BMRI 8507;
Wylie D.C. & C.W. Mah. (2004), Rock Slope Engineering, ISBN 041528001 X.

11.9. Surface Water

Craig RF (1997), Soil Mechanics, 6th Edition. Routledge, UK.
Golder (2013), Tula Kapi Mine – Long Term Acid potential and metal leaching assessment – Draft Report, Report number 12614051-12012-3.
Golder (2012), Nyota Minerals – Tulu Kapi Mine Water Balance, Report number 11613370-11575-4_Rev1.
Golder Associates and E-Tek (2011), Surface Water Inputs to EIA for Planned Underground Mining and EMP Consolidation. Golder Associates Report Number 12886-10800-8, October 2011.
Knight Piésold (2020b). Tulu Kapi Gold Project: Commissioning Water Balance Model. Memorandum. Ref. No. PE20-00182. Knight Piésold Ltd.
Midgley DC, Pitman WV, Middleton BJ (1990), Surface Water Resources of South Africa, 1990. WRC Report No 298/2.1/94, Volume 2
Peens and Associates (2011), Tulu Kapi Tailings Storage Facility Baseline Hydrological Assessment (Reference number 0082_Tulu Kapi Tailings Storage Facility Baseline Hydrological Assessment). Prepared for Epoch Resources (Pty) Ltd., Midrand.
Schulze RE (1995), Hydrology and Agrohydrology: A text to accompany the ACRU 3.0 Agrohydrological Modelling System. Water Research Commission, Pretoria, Report TT69/95, 1995.
Smithers J.C. and Schulze R.E. (2002), Design Rainfall Estimation Program (2002). Rainfall Statistics for Design Flood Estimation in South Africa, WRC Project K5/1060
US Soil Conservation Service (1986), Technical Release 55: Urban Hydrology for Small Watersheds. U.S. Department of Agriculture.
Seleshi, Y and Zanke U (2004,) Recent Changes in Rainfall and Rainy Days in Ethiopia. Int. J. Climatol. 24: 973–983.

9.10 Stakeholder Consultation/Engagement

Alemeyahu, Diro. (2004), Oromo Development Conception and Practice: An Ethnographic study of the Tuluma Oromo, Addis Ababa University: School of Graduate Study.
Bartels, Lambert. (1990), Oromo Religion: Myths and Rites of the Western Oromo of Ethiopia, an Attempt to Understand. Dietrich Reimer. Verlag: Berlin.
Baxter, Paul, Lewis I. M. (ed). (1983), The problem of Oromo or The Problem for The Oromo. Paper Contributed to National and Self Determination in the Horn of Africa. 129-149.
IFC (2007), IFC's Guidance Notes: Performance Standards on Social & Environmental Sustainability, Washington, D.C., USA.
IFC (2007a), Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets, Washington, D.C., USA.
IFC (2007), IFC's Environmental, Health, and Safety (EHS) Guidelines; GENERAL EHS GUIDELINES.
Intersocial (2014), External Monitoring & Review Report, Tulu Kapi Project, Ethiopia, Kefi Minerals PLC. 19th September 2014
Legesse, Asmarom (1987), Gada: Three Approaches to the study of African Society. The Free Press: New York.
Mid-Day International Consulting Engineers (2008), Land and Land Resource Survey for Yubdo Platinum Test/Pilot Area andTulu Kapi and Guji Detail Gold Exploration Drilling Areas in Western Welega Zone, Oromia, Ethiopia. Mineral Resource PLC. Ethiopia Gold Prospect.
Megersa, Gemetchu. (2001), The Oromo and the Ethiopian State Ideology in a Historical Perspective. Paper contributed to Ethiopia Studies: Ethiopia in Broader. 2007 IFC Guidance Notes: Performance Standards on Social & Environmental Sustainability. Washington D.C.: USA.
Nyota's stakeholder engagement log for meetings that took place between Sept 2009 - June 2010.
SRK (2010) IFC Environmental and Social Review Summary of Tulu Kapi Project, 13 April 2010.
Summary of temporary compensation process undertaken during exploration.
TKGM (undated). Stakeholder Management Plan. Tulu Kapi Gold Mine.
Western Wollega Zone Finance and Economic Development Department. June 2010. Socio-economic profile of Ganji district, Ethiopia.

9.11 Waste

Radiation Protection Proclamation No 571/2008.
Environmental Pollution Control Proclamation No 300/2002.
Water Resources Utilisation Proclamation No 92/1994.
Water Resources Management Proclamation No 197/2000.
Solid Waste Management Proclamation No 513/2007.

International Cyanide Management Code for The Manufacture, Transport and Use of Cyanide in The Production of Gold.
International Finance Corporation; Environmental, Health, and Safety (EHS) Guidelines: General EHS Guidelines.
International Finance Corporation; Environmental, Health, and Safety (EHS) Guidelines: General EHS Guidelines: Environmental Waste Management.
International Finance Corporation; Environmental, Health, and Safety (EHS) Guidelines: General Hazardous Materials Management: Guidance applicable to all projects or facilities that handle or store any quantity of hazardous materials.
International Finance Corporation; Environmental, Health, and Safety (EHS) Guidelines for Mining.
Minimum Requirements for Waste Disposal by Landfill. South African Department of Water Affairs and Forestry, Pretoria, 1998.

ANNEXES