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2018

FINAL MINE FEASIBILITY STUDY REPORT

APPROVED
WITH THE TERMS & CONDITIONS OF THE CLEARANCE FROM DOR, DOFS, NECS DZONGKHA, ETC. AS A PART OF THIS REPORT ALONG WITH VOLUME..... II .....

Sangay Tshering, GM, PMD

KHARBARI DARA STONE QUARRY
KHARBARI DARA, TADING GEWOG
SAMTSE DZONGKHAG

Promoted by:
State Mining Corporation Ltd., Samtse

26th July, 2018

GEOLOGY & MINES

CONTENTS

CHAPTER 1: EXECUTIVE SUMMARY

1.1 Introduction

State Mining Corporation Limited (SMCL) is the newest subsidiary company of the Druk Holding and Investment Limited. It was incorporated under the Companies Act of the Kingdom of Bhutan on 31 December 2014. Its primary mandate is to explore mineral resources and carry out mining activities for both export and serving the local industries. It has its corporate office at Samtse.

Realizing the potential market for stones and products in the neighboring countries, India and Bangladesh, SMCL explored for stone deposits in the south-western part of the country for stone quarry operation. After prospecting the areas of Daurpani and Khanabharti under Samtse Gewog and Tading of Tading Gewog a potential deposit was found at Kharbari Dara under Tading Chiwog of Tading Gewog, Samtse Dzongkhag. The main objective of the exploration was to find a stone quarry for export of the boulders and other stone products to India and Bangladesh, while there were potential markets, and generate revenue. The sale of the boulders and stone products will, however, not limit to export. Domestic supplies will also be made as and when there are demands.

1.2Brief of Quarry& Promoter

a) Name of promoter	:	State Mining Corporation Ltd.
b) Address	:	Samtse, P.O. Box. 320
c) Type of mining	:	Semi-mechanized
d) Lease period	:	10 years
e) Lease area	:	36.764 acres (14.877 hectares)
f) Number of annual working days	:	300

1.3 Location of Quarry

a) Location	:	Kharbari Dara
b) Gewog	:	Tading
c) Dzongkhag	:	Samtse
d) Geo-coordinates	:	26°50'54.45"N, 89°17'38.04"E to 26°51'9.67"N, 89°17'19.57"E
e) Elevation	:	680m to 945m
f) Topo-sheet No.	:	78F/5
g) Distance from Phuntsholing town	:	20km

1.4 Geological and Mineable reserve

a) Geological reserve	:	8,756,800 MT (probable)
b) Mineable reserve	:	5,283,900 MT
c) Annual production	:	528,390 MT (average)
d) Daily production	:	1760 MT (average)
e) Total waste	:	255,000 MT
f) Annual OB/waste	:	25,500 MT (average)
g) Daly OB/waste	:	85 MT (average)
h) Stripping ratio	:	1 : 0.05 (quartzite to OB/waste)

1.5 Summary

1.6. A. MINING PARAMETERS

a) Abandoned bench width	:	6m
b) Abandoned bench height	:	6m
c) Working bench width	:	6m to 80m
d) Working bench height	:	6m

1.6. B. MANPOWER

a) Managerial	:	4
b) Technical	:	3
c) Support	:	6
d) Daily wage	:	5

1.6.C. TOTAL INVESTMENT

a) P re-operative	:	Nu. 370,250.00
b) Pre-production	:	Nu. 19,391,530.00
c) Infrastructure	:	Nu. 32,720,000.00
d) Vehicle	:	Nu. 1,050,000.00
e) Office Equipment	:	Nu. 1,020,000.00
f) Others	:	Nu. 5,657,320.00
g) Advance ERB	:	Nu. 1,498,271.95
Total	=	**Nu.61,707,371.95**

CHAPTER 2: MARKET ANALYSIS

2.1 Market

Since the recent past a number of mega construction projects are being undertaken in the neighboring countries, India and Bangladesh. The Indian government has approved the execution of Rs.500 billion railway project in the north-east India. In Bangladesh, there is never ending demand of stone boulders and aggregates for construction of infrastructures such as multi storied bridges, elevated express ways, thermal plants, flood protection walls, bridges and sea ports.

2.2 Competition in the Market

There are four other quartzite quarries in Tading Gewog. All four are approved projects and one of them has been in operation since 2015. To the west, in Phunshohling Dungkhag, there are again one stone quarry and four quartzite mine in operation, out of which two sell construction grade quartzite. One more stone quarry is currently in pipeline at Renikha under Phuntsholing Dungkhag.

The quartzite mines produce Ferro-silicon grade quartzite, which is not feasible for construction purposes. In the past the quartzite mines operators use to sell quartzite rejects as construction. In the recent times such quartzite rejects are not being sold due the inferior quality for construction purposes because of presence of high silica content. Therefore the best quartzite for construction purposes is the ones in Tading.

SMCL will outrun the other quarries in the other areas in terms of the distance. However, SMCL will face tough competition from those quarries in Tading area. SMCL shall have to beat the competitors by maintaining quality in the stone products and doing a clean and reputable business.

CHAPTER 3: LEGAL FRAMEWORK

3.1 Legal and Regulatory Considerations

Any business set up is driven by its potential to supply the products, and the necessity and demand of the product. Therefore, it is essential to initially carryout a detail study of the market and then accordingly the feasibility of the project before the approval to execute the project is sought from the authorities. Therefore, the Mines and Minerals Management Act, 1995 requires, prior to granting of a mining lease, a final mine feasibility study be prepared, which shall contain an assessment of technical, financial, environmental and social parameters which demonstrate, in a reasonable manner, the socio-economic viability of the mine. The Regulations, 2002 requires the mining operator to submit all details of the market of the mine product and its conditions for the periods as specified in it. This means that the lifeline of the quarry depends on the market conditions of the quarry product and other factors, which determine feasibility of the mining project.

The approval of the project and the monitoring of its activities is also subject to the administering of the following laws of the Kingdom.

The National Environment Protection Act, 2007
Environmental Assessment Act, 2000
Regulation for the Environmental Clearance of Projects and Regulation on Strategic Environmental Assessment, 2002
Waste Prevention and Management Act, 2009
Application for Environmental Clearance: Guidelines for Mines
The Water Act of Bhutan, 2011
Forest and Nature Conservation Act of Bhutan, 1995
Forest and Nature Conservation Rules of Bhutan, 2006
The Labor and Employment Act of Bhutan 2007
The Land Act of Bhutan, 2007
Rules and Regulations for Lease of Government Reserved Forest Land & Government Land
The Local Government Act of Bhutan, 2009
Labor and Employment Act of Bhutan, 2007

4.1 Introduction

A team from the Department of Geology and Mines along with officials from the Project and Mines department of the SMCL had undertaken PFS studies on the Kharbari Dara stone quarry during the month of August 2017 for five days commencing from 24th August 2017. The PFS study undertaken by the DGM team on the Kharbari Dara stone quarry for the SMCL during the field work postulated that the site is feasible. Detailed geological mapping followed by topographical survey and surface sampling to a scale of 1:2500 with 2m contour interval was carried out during the month of October 2017. An area of 36.87 acres was geologically covered.

The quartzite rock at Kharbari Dara is fine to medium grained, hard and compact and light bluish in color and geologically belong to the Upper Pangsari of the Buxa Group and the lower Shumar Formation as separated by Shumar Thrust The
Kharbari Dara stone quarry exists as a barren and open, small hillock.

As directed by the SMCL management, technical team comprising of Geologists and Surveyors from the Projects and Mines Department of the SMCL had undertaken the geological investigation and topographical survey of Kharbari Dara Stone Quarry to a scale of 1:2500 to assess the quartzite deposit in terms of its quantity, quality and its mine ability for export of boulders and aggregates or supply in the domestic market for one month with effect from 3rd. October to 8 November 2017.

The KharbariDara Stone quarry is located at an altitude of 840m within the co- ordinates of Latitude: N26°50´59.63´´ andlongitude: E89°17´ 26.04´´in parts of topo-sheet no 78F/5.
The quartzite rock at Kharbari Dara is fine to medium grained, hard and compact and light bluish in color and geologically belong to the Upper Pangsari of the Buxa Group and the lower Shumar Formation as separated by Shumar Thrust. The Kharbari Dara stone quarry exists as an open, small hillock. The deposit has virtually very thin overburden consisting of residual soil with scattered quartzite boulders with thicker on the topographically gentle area sand thinner on steeper slopes. Two varieties of quartzite are seen in the proposed area. Light grey quartzite is seen exposed in the top part and another light bluish colored quartzite
Is exposed at basal part. The strike of the quartzite band is N80°W-S80°W with dip amount varying from 20°-45°towards North east.

Grab samplings of quartzite along 3 selected sample lines that were laid across the quartzite band over a stretch of 400m were collected to determine their quality parameters. A total quartzite resource potential from Kharbari Dara Stone Quarry is estimated as 8.76 million tons by cross-sectional method considering the down dip of 25m and the specific of quartzite as2.6.

The deposit has virtually very thin overburden consisting of residual soil and scattered quartzite boulders of various as sorted sizes, with thicker on the topographically gentle areas and thinner on steeper slopes. Two varieties of quartzite are seen in the proposed area. Light grey quartzite is seen exposed in the top part and another light bluish colored quartzite is exposed at the basal part.

Further the dump yard for the Kharbari Dara stone quarry was earlier proposed at Swami Tar on the upstream of Purbay Kholsa during the PFS study by DGM team. The dump yard at Swami Tar is very small and narrow. It is reported to be close to the community forest. A suitable dump yard at Ang Garay Tar in the north eastern part within the SFL and was identified during the course of the detailed investigation. The dump yard is flat and measures about 1.8 acres.

4.2 Location and Accessibility

The Kharbari Dara quartzite deposit lies at a radial distance of 9 kilometers south- west of Phuentsholing town in the topo-sheet No78F/5.It lies two kilometers away from the upper Tading chiwog of the Tading Gewog under Samtse Dzongkhag.

The upper Tading village is connected by a motorable road from the Indian town of Madarihat. The upper Tading village is accessible by a 29km motorable road from Madarihat. Three kilometers (3km) of this stretch are along a hilly terrain. This stretch is narrow and rough. Almost the entire stretch of this road lies in the Indian side of the border. The Tota Para is located near the Indo-border point in the immediate vicinity of Tading Gewog of Samtse Bhutan.

Another approach point to reach the site is through the Tursa-Tading farm road. The distance along Tading-Tursa farm road is 10km and from Tursa, it is 20km to Phuentsholing town. This point of approach ability through the national territory to the quarry site appears to be viable in the context of security point of view.

An approach road for lengths of 3 kilometers is to be constructed to reach at the top of the deposit site from the existing Jenchu-Tading farm road, through the government reserved forest land. The take up point for approach road is from Purbay Doban (Lower Tading). From Purbay Doban, it is 7km to the Tursa Bridge Point on Phuentsholing-Samtse highway on the existing Tading -Jenchu farm road. The quarry is bounded by the following geographical coordinates: Latitude:N26° 50′59.63′′Longitude:E89°17′26.04′′.The deposit is bounded by Purbay Kholsa in the south and Tarika Kholsa in the north.

4.3 Physiographic, Drainage and Climate

The area forms a part of the Himalayan foothill belt. The topography of the proposed stone quarry is rugged with narrow ridges, steep slopes and deep depressions at places. The studied area lies on an east-west trending ridge at elevations of 790m-954m from MSL. The Kharbari Dara quartzite deposit lies in between Purbay Kholsa and Tarika

Kholsa. The Purbay Kholsa is perennial whereas Tarika Kholsa is seasonal one. Both these streams flow towards north-east to southeast direction and finally drain into Tursa river at Jenchu.

4.4 Flora and Fauna

Flora:

Abroad picture of the proposed quarry of the floral dominance was also obtained through literature review and past studies conducted in the surrounding areas. The general vegetation recorded in the area as per earlier studies conducted is shown in the table below:

Table 1: Vegetation recorded in the area

Sl. No.	Name of Species	Local name	Economic value
1	*Alanthusgrandis*	Gokul	Firewood
2	*Castanopsis*	Aule Katus	Firewood
3	*Ficus hispida*	Koksa	Fodder
4	Morus macrooura	Kimbu	Timber
5	*Tetramelos*	Maina	Timber
6	Pterospermum acerifolium	Hathipaile	Construction work
7	Duabanga Grandiflora	Lampathey	Construction work
8	Dalbargia stipulcia	Laha Siris	Firewood
9	Terminalia myuriocarpa	Panisaj	Timber
10	*Bamboo*		Craft making, construction etc
11	*Sal*	Soriarobusta	Timber
12	*Hallock*	Terminalia	Timber
	Simul	Bombale malabaracium	Fire wood

The trees in the quarry site ranges in heights of 5 to 20 metres, with varied thickness. The tree density including both big and small trees estimated in the area is around 250 trees. The under growths are thick and are covered with numerous shrubs and herbaceous plants.

Fauna:

During the geological study, birds, insects, butterflies and lizards were observed within the core area of the stone quarry. No mammals were observed in the course of field work although as per local in formation, animals such as deer, monkeys, wild boar and wild goats are usually sighted in the area. Literature review of past studies provided abroad understanding on the type of animal life in the area.

Table 2: The list of major faunal species

Sl. No.	SCIENTIFIC NAME	LOCAL NAME
1	Macaca assamensis	Monkey
2	Cuon alpines	Wild dog
3	Ursus thibetanus laniger	Himalayan black bear
4	Canis aureus	Jackal
5	Herpestes urva	Mongoose
6	Panthera pardus	Leopard
7	Prionailurus bengalensis	Leopard Cat
8	Sus scrofa	Wild boar
9	Cervus unicolor	Sambar
10	Muntiacus mutjak	Barking deer
11	Semnopithecus entellus	Grey langur
12	Cynopterus sphinx	Bat
13	Hysterix indica	Porcupine
14	Funambulus pennati	Squirrel
16	Mus musculus	Mouse
17	Pitton morurus	Python
18	Naja naja	Cobra
19	Naja Hannah	King cobra
20	Varanus spp.	Lizard

4.5 Regional Geology

The KharbariDara area exposes the rocks of the Himalayan frontal belt trending in ENE-WSW direction with shallow to moderate dips to North. The tectonic succession of the area from North to South is as follows:

Shumar Formation: Variegated calcareous quartzite with bands of dark grey, carbonaceous shale, talcose bands, and white to greenish, grey massive quartzite with occasional pebble beds. Its lower boundary is limited by a thrust line.

Manas Formation: Grey phyllite, carbphyllite, quartzite and lime stone bands, grey to light grey dolomite with phyllite and thin lime stone bands. Its lower boundary is limited by the upper boundary of the Phuentsholing Group of rocks.

Phuentsholing Group of rocks: Variegated purple and green phyllite and quartzite, minor limestone and metabasic sills. Its lower boundary is limited by the MBT. To the further south, it is followed by the alluvium.

Table 3: Tectono-stratigraphic order of superposition

Rock Formation	Lithology Description
Pangsari Formation	White to cream, fined grained are nacreous dolomite, subordinate grey green, locally talcose phyllite and white, lightgrey, fine to medium grained sporadically calcareous quartzite, locally pebbly to conglomer anti-white clast of jasper, red quartzite.
Phuentsholing Formation	Alternating sequence of white-light grey fine to medium grained quartzite light to dark grey, green, greenish grey phyllite, phyllite slate; rare carbonate.
Manas Formation	Intercalated sequence of white-grey fined to medium grained, locally gritty/pebbly to conglomeratic quartzite containing clast of jasperandred quartzite; Grey rare creamish grey dolomite light to dark grey
Jainti Formation - A	Pink subordinate white fined to medium grained Quartzite locally gritty/pebbly containing clast of jasper; thin parting of maroon purple greengrey phyllite.
Jainti Formation - B	Maroon purple, green-grey phyllite; meta silt stone and quartzite.

4.6 Local Geology

The KharbariDara stone Quarry area occurs within the Buxa Group of rocks disposed in roughly east-west trending hill. During the geological investigation at KharbariDara stone quarry area, we met with basically two types of rock viz. quartzite and phyllite.

The quartzite rock at KharbariDara is fine to medium grained, hard and light bluish in colour and geologically belong to the Phuentsholing Formation. It exists as a barren and open, small hillock with minimum over burden. The description of individual rock types met in the explored area at Kharbari Dara stone quarry are as follows

4.7 Phyllite

This is the lower litho unit of the quartzite deposit. It is grey to dark grey and occasionally greenish with numerous quartz vein intrusions along the foliation and fractured plane. The phyllite shows calcareous nature near the contact with the quartzite exposure. The phyllite at the study area is fined grained and light to dark grey, green, greenish grey phyllite and flaky phyllite. The phyllite occurs at basal part of quartzite band.

4.8 Quartzite

The quartzite deposit at KharbariDara falls under the Manas Formation. It comprises a heterogeneous assemblage of detrital and homogenous sediments consisting of phyllite, quartzite, limestone and dolomite. These meta-sediments are un-fossiliferous. The general strike of these rocks is ENE-SWS with shallow to moderate dip towards NNW.

The rocks of Shumar Formation comprising of whit to greenish grey quartzite, pebble beds, calcareous quartzite and phyllite tectonically overlie the Manas Formation. The quartzite generally forms steep rising hills and cliffs. The lower contact of quartzite deposit is marked by grey to greenish grey phyllite and no upper contact was observed as the whole ridge is exposed as quartzite.

The quartzite at KharbariDara is dull white to light greenish grey in colour, fine to medium grained, highly fractured and join ted with quartz along the bedding plane. Two varieties of quartzite are seen in the proposed area. Light grey quartzite is seen exposed in the top part and another light bluish colored quartzite is exposed at the basal part. The strike of the quartzite band is N80°E-S80°Wwith dip amount varying from 20°-45°towards North West.

Construction material like Quartzite is a hard, non-foliated metamorphic rock which was originally sand stone. Quartzite is a popular stone in the construction industry. When quartzite is split, it splits through the quartz granules rather than around the mas s and stone splits. This allows quartzite to be split into flat surfaces. There are list of the properties of quartzite, which makes it a popular choice for various types of construction works:

•One of the major properties of quartzite rock is high resistance to wear and tear. This is a very hard stone and is also resistant to weathering.
•Properties like durability and suitability to every type of construction project is one of the major reasons for its popularity. •Quartzite has high abrasion hardness and is also resistant to harsh chemical attacks.
•The surface of the stone is also very glossy, which is helpful for decoration and landscaping purposes.
•It is available naturally in various forms, textures, and colours. It has a high aesthetic appeal and thus can be used for decorating the outer walls of the houses.
•It is suitable for use in all surfaces-hones, polished, sand blasted, or flamed. Also because of its hardness and angular shape, crushed quartzite is often used in as railway ballast. Crushed quartzite is sometimes used in road construction. High purity quartzite is used to produce ferrosilicon, industrial silica sand, silicon and silicon carbide. Owing to its ability to split along the foliations, it is generally used for wall claddings. The granoblastic form of the stone has a medium-grained texture that allows the material to be used in the construction of floors. Various other types of exterior and interior designer tiles are also created with such stones. The stone is also aperfect choice for the construction of pool decks, entrances, stair treads. It is considered to be the best choice for areas where foot traffic is heavier. Quartzite rock is used on water way embankments to prevent soil erosion. Dirt roads, parking lots, drive ways and walkways are grated and topped with quartzite rock. More finely-crushed rock is used in the making of concrete.

Advantages of using quartzite in the construction industry are:
•It is an extremely hard stone and lacks tiny orifices. The texture of the stone will prevent people from slipping even when water spills on them.
• Dirt generally does not accumulate due to its smooth surface and it can with stand stress.

4.9Surface Sampling

For resource assessment purposes, materials for study must adequately represent the variations of those parameters which influence the suitability of a rock for different uses. To achieve this objective, grab samples of quartzite were collected from the 3 selected sample lines laid across the general trend of the quartzite band. Along each sample line, rock samples varying in number from 4-5 nos were collected with sample code i) KDQ-1/1,KDQ-2/1,KDQ-3/1,ii)KDQ-2/1,KDQ-, 2/2,KDQ-2/3andiii)KDQ-3/1,KDQ-3/2 and KDQ3/3 for geotechnical analysis in the Bhutan Standard Bureau in Thimphu. The rock samples were given to the laboratory at Bhutan Standard Bureau in Thimphu for analysis of Aggregate Impact Value (AIV), crushing test (ACV), LosAngeles Abrasion test, Water Absorption test, Specific gravity and Bulk density on dated 9thNovember 2017 by the General Manager PMD.

4.10 Evaluation of test

Geotechnical properties of rocks play an important role in the design of engineering structures. Several types of geotechnical properties of materials called "Index properties" provide basis of evaluation for almost all types of civil engineering works that involve use of rocks. The index property test must be relevant to the engineering requirement sand must

be reproducible. Generally such tests are carried out in large number to obtain a reliabl picture.

All such test provides basic information on the physical properties of rock sand thei mechanical behavior. In order to decide the suitability of the different engineering requirement, following geotechnical tests are carried out at BSB (Bhutan Standards Bureau)

- Aggregates impact value test (AIV)
- Crushing test(ACV)
- Los Angeles Abrasion test
- Water absorption test
- Specific Gravity
- Bulk Density

4.11 Test results

Table 4: Test results of the samples from Kharbari Dara

Sample No.	Samples	Results					
		ACV (%)	LAA (%)	AIV (%)	WA (%)	Sp. Gr	B. Density
1	KDQ1/1	16.71	20.48	11.74	0.39	2.58	2.92
2	KDQ2/1	22.38	21.58	21.22	0.4	2.62	1.49
3	KDQ3/1	18.06	21.12	13.73	0.7	2.63	1.45
Average		19.08	21.06	15.56	0.49	2.61	1.95

Aggregate Crushing Value Test

The objective of this test is to:

1. Determine the aggregate crushing value of coarse aggregate
2. Assess suitability of coarse aggregates for use in different construction materials.

Aggregate crushing value is a numerical index of the strength of the aggregate and it is used in construction of roads and pavements.

Crushing value of aggregates indicates its strength. Lower crushing value is recommended for roads and pavements as it indicates a lower crushed fraction under load and would give a longer service life and a more economical performance.

Aggregate Crushing Values for Roads and Pavement Construction

Thetablebelowshowslimitsofaggregatecrushingvaluefordifferenttypesof road construction:

Table 5: Aggregate Crushing Value

Types of Roads/Pavements	Aggregate Crushing Value
Flexible Pavements	
Soling	50
Water bound macadam	40
Bituminous macadam	40
Bituminous surface dressing or thin premix carpet	30
Dense mixcarpet	30
Rigid Pavements	
Other than wearing course	45
Surface or Wearing course	30

A CV value of less than 30% can be used for road and while ACV value less than 45% can be used for concrete works. With regards to ACV, average ACV from the Kharbari Dara Stone Quarry is 19.08% which indicate in the" strong" category and can be used as good construction materials.

Los Angeles Abrasion Test

Los Angeles abrasion test on aggregates is the measure of aggregate toughness and abrasion resistance such as crushing, degradation and disintegration. The aggregate used in surface course of high way pavements are subjected to wearing due to movement of traffic.

Therefore, the road aggregates should be hard enough to resists abrasion. The aggregates to be used as road construction abrasion value should be less than 30% and aggregate to be used as building stone it should be less than 50%.

Average abrasion value from the Kharbari Dara Stone Quarry is 21.06 which can used as good construction materials

Aggregate Impact Value Test

The aggregate crushing value is defined as a ratio of the weight of fine passing the specific IS Sieve to the total weight of sample expressed a percentage. The property of a material to resist impact is known as toughness. Due to movement of vehicles on the road the aggregates are subjected to impact resulting in their breaking down into smaller pieces. The aggregates should therefore have sufficient toughness to resist their disintegration due to impact. This characteristic is measured by impact value test.

The aggregate impact value is a measure of resistance to sudden impact or shock, which may differ from its resistance to gradually applied compressive load.

Classification of aggregates using Aggregate Impact Value is as given below:

Table 6: Aggregate Impact Value

Aggregate Impact Value	Classification
<20%	Exceptionally Strong
10–20%	Strong
20-30%	Satisfactory for road surfacing
>35%	Weak for road surfacing

The aggregates to be used as concrete works, AIV should be less than 45% and for road construction it should be less than 30%. The tests result from Kharbari Dara Stone quarry indicates AIV in from 11.74% to 21.22%. Therefore the aggregate is exceptionally strong and suitable to be used as road construction and other construction materials.

Specific Gravity

Heavier variety of stone should be used for the construction of dams, bridge and retaining walls. The specific gravity of good construction material is between 2.4 and 2.9. The tests result indicate that specific gravity is 2.6 it can be used as good construction materials.

Water Absorption

The capacity of a material to absorb and retain water in it is known as water absorption. It is expressed in % of weight of dry material. It depends upon the size, shape and number of pores of material.

All stone have pores and hence absorb water. Their action of water with material of stone causes disintegration. Absorption test is specified as percentage of water absorbed by the stone when it immersed under water for 24 hours. For a good construction/building stone it should be as small as possible. The aggregates to be used as road construction water absorption should be less than 2%. The water absorption of Kharbari Dara Stone Quarry are in 0.49 which indicate it can be used as road construction.

Reserve estimation is the most important part of any exploration programed. The reserve of quartzite rock in the area has been estimated by the geological-section methods. Three geological cross-sections along A-A', B-B' and C-C' have drawn across the quartzite band on the geological map of the stone quarry. The average strike length of the quartzite band within demarcated area is 400m.

Since quartzite is a metamorphic rock, the lateral up dip or down dip variations are not expected much. The down dip extension for the current case has, therefore, been kept at 25m. The specific gravity of the quartzite was taken as 2.6.
Therefore, 8.76million tons of quartzite deposit was calculated as the geological reserve as shown below:

Table 7: Reserve calculation

Sl. No	Profile lines	Cross-sectional area of quartzite(m^2)	Down dip extension	Volume (m^3)	Specific Gravity	Reserve (metric tons)
1	A-A'	60,500	25	1,512,500	2.6	3,932,500
2	B-B'	61,300	25	1,532,500	2.6	3,984,500
3	C-C'	46,600	25	1,165,000	2.6	3,029,000
Total reserve:						10,946,000
20%deductiondue to mining loss and contamination:						2,189,200
Net geological reserve:						8,756,800

Allowing 20% deductions towards loss due to contamination, the net geological reserve potential of the quartzite deposit from the Kharbari Dara stone quarry stands at 8.76 million tons.

CHAPTER 5: MINE DEVELOPMENT PLANNING

5.1 Determination of Pit Boundary and the Area for Ancillary Facilities

The determination of a pit boundary depends on number of factors and constraints. They are; behavior and attitude of the deposit and its reserve, topography, the mining lease area, availability of waste dumpsite and its lead distance, concept of mining optimization, the ancillary facilities required and the mine environment.

The quarry upper boundary is fixed on the slope break at the elevation 962m MSL. The quartzite contact starts at 950m in the west, dipping toward the north-east, and 920 in the north-east. It is about 220m thick and lies below a gently sloping ridgeline facing east.

With few OB benches development at the top section the upper pit boundary is set at 960m RL to start the quarry benches configuration from the slope break on the ridge top. Initially the benches are faced east and after few years the benches are turned toward the north-east. This will happened in the mid of third year. This is will avoid impact on Purbay kholsa stream and moreover the quarry approach road below.

The quarry benches are configured for the maximum extraction of the probable quartzite reserve. The lower limit of the quarry pit is set to extract the all the quartzite at the lower level even if there was need to remove and manage the phyllite. The last bench level at the end of the ten years quarry operation is at 704M RL.

5.2 Access Road

Two stretches access roads shall be constructed; one (1.1km) from Tading farm road at Purbay Khola riverbed up to the junction of Tading farm road and Daradara/Chitwadara approach road and the other (0.2km) from Daradara road to the eastern boundary of SMCL quarry. 1.6km of existing private quarry approach road will connect the two SMCL's new roads. Therefore, the total approach road of Kharbari Dara Stone Quarry, from Tading farm road till the quarry boundary shall be 2.9km. From the quarry boundary internal road of 0.9km will give access to the quarry top from where the first OB bench will be developed.

5.3 Pre-production

The other developmental activities include construction of infrastructures such as the office, staff quarters, stores, motor vehicle and machineries repair shop and the preparation of the OB dumpsite. The office, staff quarters and stores shall be taken on rent basis in the nearby villages of Tading and Lower Tading. This will be one of the opportunities to the community to make some income. However, a hutment shall be made on a private land outside and near the quarry for the daily wage labourers. With regard to the OB preparation the gabion wall for the first year OB dumping shall be constructed once after the access road to the dumpsite is made. The details of the OB wall is given in the capital expenses section of this report.

The development work also includes the completion of the OB benches development until the mineral/rock is exposed for extraction.

CHAPTER 6: MINE DESIGN PARAMETERS AND PRODUCTION

Economic material extraction depends on the availability of good working faces and exposure of fresh material so that desired production is achieved, manpower and equipment is properly utilized and products of commercial value is obtained. Since the top layer of the deposit is covered with a thin layer of overburdern, about 0.5 to 1m, its removal will be carried with earth moving equipment to expose underlying material. Some of the factors that area taken into account during the development are:

- Nature of deposit
- Equipment availability, selection and cost
- Casual workers that will be required and are actually not available in the market
- Volume and specification of material desired
- Loading location and method

The objective of a proper mine development is to create sufficient space within the mineral zone to accommodate manpower and basic equipment for commercial production on a continuous basis.

6.1 Bench Dimension

Maintaining specific bench dimensions is not only the requirement of the rules but to ensure slope stability and minimize environment degradation. It also becomes a cost saving method of mining operation in terms of managing the environment toward the end of the mining life or the lease term.

In line with the mining rules and regulations and the efficient operation by selecting appropriate machineries the bench dimensions are designed. In the case of Kharbari Dara Stone Quarry, it is 6m bench height and 6m width. The working bench height and width, however, will differ during the working phase. The other parameter is to ensure that the ultimate pit slope angle is not more than 45^0 at the end of the mining life.

6.2 Drilling and Blasting

It has been learnt that ripper deployment is more efficient and safe to extract boulders from the in-situ rock bed. An XR50 ripper can extract $150m^3$ of rock in one hour. In one day it can produce about 200 TL of quartzite. This means that deployment of only one ripper is more than enough to meet the daily target production. Though ripper operation will be continuous it will not produce sound and vibration of that made by using explosives. Therefore, SMCL has chosen to use the ripper over the explosives. However, if the rock properties do not allow the use of the machine a separate proposal for the use of the explosives will be submitted to the Department of Geology and Mines for approval.

6.3 Haul Road and Ramp

The main access road passes through the quarry bench configuration. As the benches advance downslope the access road will be cut through. It is aligned such that as operational years progress the quarry benches is connected to it without the requirement of constructing connecting roads. The average gradient of the approach and internal access roads is 1 in 12, where as the ramps will be 1 in 7.

6.4 Waste Dump

The OB dumpsite lies on the lower boundary at the north-east, between DP8 and DP10. A gabion wall will be made along the boundary. The OB dumping will start at 670m RL and will be fill up till 700m RL. For the first year a strong gabion wall shall be made along the boundary between the DPs mentioned above. As the operational years progress series of walls shall be made upslope. There will be some open space left between DP8 and DP9 for extension of the dumpsite in the future, if the initial dumpsite is not sufficient.

The retaining capacity of the current OB dumpsite is calculated as follows:

Length of the gabion wall = 85m
Slope distance = 90m
Average height of OB = 30m
Volume = 2,29,500m^3

The current OB dumpsite, shown in the pit plans, will accommodate 229,500m^3 of OB.

6.5 Final Pit Configuration

The quarry is being planned to be operated continuously from top to bottom starting from 960m RL. The benches will face east initially and then north-east from the mid of third year of operation. The intention of changing the direction of the benches configuration is to impact on the Purbay Kholsa stream below.

By the end of the lease there will be 44 quarry benches operated with the final bench on the 704m RL.

6.6Quartzite Production

The first bench cutting in the OB starts from 966m to 968m RL. The first bench height shall be 4 to 6 m. After some years of operation top bench is again advance from farther up. However the first bench level will be maintained at 962m only. Since it is gentle area back advancement allows to main the top and first bench to be maintained at the same level. The backward advancement is being done to get production in the initial years of the operation and to maintain a continuous production through the quarry life. The following tables show year wise production planning with annual targets. The tables will also guide the implementing operational team at site to follow the backward advancement.

YEAR 1 PRODUCTION PLAN:

Year 1: Bench wise production					Sp. Gr. of quartzite :		2.6			Sp. Gr. of OB :	2.0
Quarry Bench		QRTZ HEIGHT	QRTZ LENGTH	QRTZ WIDTH	QRTZ VOL	TONNAGE	OB HEIGHT	OB LENGTH	OB WIDTH	OB+Waste VOL	TONNAGE
FROM	TO										
968	962	0	0	0	0	0	6	5.7	45.28	1,548.58	3,097.15
962	956	0	0	8.72	0	0	6	27.7	48.74	8,100.59	16,201.18
956	950	0	0	16.87	0	0	6	56.9	36.32	12,399.65	24,799.30
950	944	5	26.9	59.32	3,989.27	10,372.10	1	46.6	32.85	1,730.27	3,460.55
944	938	5	32.97	31.11	2,564.24	6,667.03	1	55.73	24.43	1,489.70	2,979.39
938	932	5	37.49	33.7	3,158.53	8,212.18	1	66.31	18.2	1,364.77	2,729.54
932	926	5	51.58	44.76	5,771.80	15,006.69	1	63.72	12.12	1,060.88	2,121.75
Total					15,483.85	40,258.00				27,694.43	55,388.85
Stripping ratio (quartzite to OB & waste) 1:					1.38						

YEAR 2 PRODUCTION PLAN:

Year 2: Bench wise production					Sp. Gr. of quartzite :		2.6			Sp. Gr. of OB :	2.0
Quarry Bench		QRTZ HEIGHT	QRTZ LENGTH	QRTZ WIDTH	QRTZ VOL	TONNAGE	OB HEIGHT	OB LENGTH	OB WIDTH	OB+Waste VOL	TONNAGE
FROM	TO										
926	920	5	96.06	53.5	12,848.03	33,404.87	1	34.44	6.13	853.52	1,707.04
920	914	5	137.39	55.7	19,131.56	49,742.05	1	5.51	20.05	1,067.05	2,134.11
914	908	5	148.03	57.54	21,294.12	55,364.70	1	7.17	9.8	1,134.97	2,269.94
908	902	5	107.2	59.2	15,865.60	41,250.56	1	11.5	11.54	925.99	1,851.98
902	896	5	112	62.69	17,553.20	45,638.32	1	11.9	10.6	1,003.80	2,007.60
896	890	6	132	14.8	5,860.80	15,238.08	0	0	0	293.04	586.08
890	884	5	86.33	57.67	12,446.63	32,361.23	1	35.67	12.5	1,068.21	2,136.41
884	878	6	125.6	21.2	7,988.16	20,769.22	0	0	0	399.41	798.82
Total					112,988.09	293,769.02				6,745.99	13,491.98
Stripping ratio (quartzite to OB & waste) 1:					0.05						

YEAR 3 PRODUCTION PLAN:

Year 3: Bench wise production **Sp. Gr. of quartzite : 2.6** **Sp. Gr. of OB : 2.0**

Quarry Bench		QRTZ	QRTZ	QRTZ	QRTZ VOL	TONNAGE	OB	OB	OB	OB+Waste	TONNAGE
FROM	TO	HEIGHT	LENGTH	WIDTH			HEIGHT	LENGTH	WIDTH	VOL	
878	872	6	129.4	48.25	18,730.65	48,699.69	0	0	0	936.53	1,873.07
872	866	6	188.7	14.54	8,231.09	21,400.84	0	0	0	411.55	823.11
866	860	6	193.91	68.25	39,703.07	103,227.99	0	0	0	1,985.15	3,970.31
860	854	6	192.6	15.1	8,724.78	22,684.43	0	0	0	436.24	872.48
854	848	6	214.5	66.89	43,043.72	111,913.66	0	0	0	2,152.19	4,304.37
848	842	6	230.2	24.43	16,871.36	43,865.53	0	0	0	843.57	1,687.14
842	836	6	242.9	69.14	50,382.32	130,994.03	0	0	0	2,519.12	5,038.23
Total					**185,686.99**	**482,786.17**				**9,284.35**	**18,568.70**
Stripping ratio (quartzite to OB & waste) 1:					0.04						

YEAR 4 PRODUCTION PLAN:

Year 4: Bench wise production					**Sp. Gr. of quartzite :**		**2.6**		**Sp. Gr. of OB :**		**2.0**
Quarry Bench		QRTZ	QRTZ	QRTZ	QRTZ VOL	TONNAGE	OB	OB	OB	OB+Waste	TONNAGE
FROM	TO	HEIGHT	LENGTH	WIDTH			HEIGHT	LENGTH	WIDTH	VOL	
836	830	5.5	242.82	21.2	28,312.81	73,613.31	0.5	17.08	16.48	1,556.38	3,112.76
830	824	5.5	237.6	19.65	25,678.62	66,764.41	0.5	24.8	13.6	1,452.57	2,905.14
824	818	6	274	18.91	31,088.04	80,828.90	0	0	0	1,554.40	3,108.80
818	812	6	284.8	18.79	32,108.35	83,481.72	0	0	0	1,605.42	3,210.84
812	806	6	279.4	18.55	31,097.22	80,852.77	0	0	0	1,554.86	3,109.72
806	800	6	271.3	18.93	30,814.25	80,117.06	0	0	0	1,540.71	3,081.43
800	794	6	260	18.7	29,172.00	75,847.20	0	0	0	1,458.60	2,917.20
794	788	6	248.1	18.64	27,747.50	72,143.51	0	0	0	1,387.38	2,774.75
788	782	6	242.3	18.98	27,593.12	71,742.12	0	0	0	1,379.66	2,759.31
968	962	0	0	0	0	0	6	4.5	45.35	1,224.45	2,448.90
962	956	0	0	0	0	0	6	24.3	48.14	7,018.81	14,037.62
956	950	0	0	0	0	0	6	50.5	36.23	10,977.69	21,955.38
950	944	6	71.4	59.77	25,605.47	66,574.22	0	0	0	1,280.27	2,560.55
944	938	6	84.9	31.92	16,260.05	42,276.12	0	0	0	813.00	1,626.00
Total					**305,477.44**	**794,241.35**				**34,804.20**	**69,608.41**
Stripping ratio (quartzite to OB & waste) 1:					0.09						

YEAR 5 PRODUCTION PLAN:

Year 5: Bench wise production **Sp. Gr. of quartzite : 2.6** **Sp. Gr. of OB : 2.0**

Quarry Bench		QRTZ HEIGHT	QRTZ LENGTH	QRTZ WIDTH	QRTZ VOL	TONNAGE	OB HEIGHT	OB LENGTH	OB WIDTH	OB+Waste VOL	TONNAGE
FROM	TO										
938	932	5	46.85	79.93	9,361.80	24,340.68	1	52.65	37.23	2,428.25	4,856.50
932	926	5	73.02	65.69	11,991.71	31,178.44	1	43.88	29.74	1,904.58	3,809.15
926	920	5	95.85	65.23	15,630.74	40,639.92	1	33.95	19.98	1,459.86	2,919.72
920	914	5	119.82	65.32	19,566.61	50,873.18	1	23.38	10.23	1,217.51	2,435.02
914	908	5	148.53	67.87	25,201.83	65,524.75	1	6.87	8.34	1,317.39	2,634.77
908	902	6	166.4	69.73	34,809.22	90,503.96	0	0	0	1,740.46	3,480.92
902	896	6	179.2	70.63	37,970.69	98,723.79	0	0	0	1,898.53	3,797.07
896	890	6	187.3	72.47	40,720.89	105,874.32	0	0	0	2,036.04	4,072.09
890	884	6	142	74.12	31,575.12	82,095.31	0	0	0	1,578.76	3,157.51
Total					226,828.60	589,754.36				15,581.37	31,162.75
Stripping ratio (quartzite to OB & waste) 1:					0.05						

YEAR 6 TO 10 PRODUCTION PLAN:

Year 6-10: Bench wise production					Sp. Gr. of quartzite :		2.6			Sp. Gr. of OB :	2.0
Quarry Bench		QRTZ	QRTZ	QRTZ	QRTZ VOL	TONNAGE	OB	OB	OB	OB+Waste	TONNAGE
FROM	TO	HEIGHT	LENGTH	WIDTH			HEIGHT	LENGTH	WIDTH	VOL	
884	878	6	160.2	65.32	31,392.79	81,621.26	0	0	0	1,569.64	3,139.28
878	872	6	172.6	64.66	33,480.95	87,050.46	0	0	0	1,674.05	3,348.09
872	866	6	170.7	63.9	32,723.19	85,080.29	0	0	0	1,636.16	3,272.32
866	860	6	210	63.57	40,049.10	104,127.66	0	0	0	2,002.46	4,004.91
860	854	6	171.6	63.43	32,653.76	84,899.79	0	0	0	1,632.69	3,265.38
854	848	6	187.6	62.44	35,141.23	91,367.20	0	0	0	1,757.06	3,514.12
848	842	6	232.8	61.12	42,686.21	110,984.14	0	0	0	2,134.31	4,268.62
842	836	6	244.7	60.7	44,559.87	115,855.66	0	0	0	2,227.99	4,455.99
836	830	6	253.2	61.17	46,464.73	120,808.30	0	0	0	2,323.24	4,646.47
830	824	6	260.5	60.27	47,101.01	122,462.61	0	0	0	2,355.05	4,710.10
824	818	6	271.7	62.21	50,707.37	131,839.16	0	0	0	2,535.37	5,070.74
818	812	6	269	61.24	49,420.68	128,493.77	0	0	0	2,471.03	4,942.07
812	806	6	262.3	61.2	48,158.28	125,211.53	0	0	0	2,407.91	4,815.83
806	800	6	254.2	59.72	45,542.47	118,410.43	0	0	0	2,277.12	4,554.25
800	794	6	244.7	58.1	42,651.21	110,893.15	0	0	0	2,132.56	4,265.12
794	788	6	233.4	59.33	41,542.87	108,011.45	0	0	0	2,077.14	4,154.29
788	782	6	222.5	61.45	41,017.88	106,646.48	0	0	0	2,050.89	4,101.79
782	776	6	216	60.81	39,404.88	102,452.69	0	0	0	1,970.24	3,940.49
776	770	6	206	59.99	37,073.82	96,391.93	0	0	0	1,853.69	3,707.38
770	764	6	202	59.55	36,087.30	93,826.98	0	0	0	1,804.37	3,608.73
764	758	6	204	59.87	36,640.44	95,265.14	0	0	0	1,832.02	3,664.04
758	752	6	203	59.88	36,466.92	94,813.99	0	0	0	1,823.35	3,646.69
752	746	6	214.3	59.89	38,503.28	100,108.53	0	0	0	1,925.16	3,850.33
746	740	6	226.1	58.35	39,578.81	102,904.89	0	0	0	1,978.94	3,957.88
740	734	6	233.5	57.91	40,565.96	105,471.48	0	0	0	2,028.30	4,056.60
734	728	6	239	55.71	39,944.07	103,854.58	0	0	0	1,997.20	3,994.41
728	722	6	256.6	53.59	41,253.58	107,259.31	0	0	0	2,062.68	4,125.36
722	716	6	211.7	48.61	30,872.21	80,267.75	0	0	0	1,543.61	3,087.22
716	710	6	262.6	41.45	32,654.31	84,901.21	0	0	0	1,632.72	3,265.43
710	704	6	270.7	38.75	31,468.88	81,819.08	0	0	0	1,573.44	3,146.89
Total					1,185,808.04	3,083,100.91				59,290.40	118,580.80
Stripping ratio (quartzite to OB & waste) 1:					0.04						

SUMMARY OF PRODUCTION PERIOD:

	Sp. Gr. Qtz:	2.6	Sp. Gr. OB:	2	Quarry waste:		5%
	Quartzite (m^3)	Quartzite (MT)	OB (m3)	OB (MT)	Waste (m_3)	Actual Quartzite (MT)	Total OB+Waste (m^3)
Year 1	15,483.85	40,258.00	27,694.43	55,388.85	774.19	39,483.81	28,468.62
Year 2	112,988.09	293,769.02	6,745.99	13,491.98	5,649.40	288,119.62	12,395.39
Year 3	185,686.99	482,786.17	9,284.35	18,568.70	9,284.35	473,501.82	18,568.70
Year 4	305,477.44	794,241.35	34,804.20	69,608.41	15,273.87	778,967.48	50,078.08
Year 5	226,828.60	589,754.36	15,581.37	31,162.75	11,341.43	578,412.93	26,922.80
Year 6-10	1,185,808.04	3,083,100.91	59,290.40	118,580.80	59,290.40	3,023,810.51	118,580.80
Total	**2,032,273.01**	**5,283,909.81**	**153,400.74**	**306,801.49**	**101,613.65**	**5,182,296.16**	**255,014.39**
Stripping ratio (quartzite, MT to OB & waste, MT) 1:							0.05
Average annual quartzite in MT=						518,229.62	
Average annual OB+waste in m3=							12,750.72
Average annual OB+waste in MT=							25,501.44

DAILY PRODUCTION:

	YEARLY OUTPUT (in mt)					
YEAR	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6-10
Quartzite (MT)	40258	293769	482786	794241	589754	3083101
Daily production (MT)	134	979	1609	2647	1966	2055
Overburden (MT)	28469	12395	18569	50078	26923	118580.8
Daily OB (MT)	95	41	62	167	90	79

HOUR LY PRODUCTION:

NUMBER OF WORKING DAYS						
Quartzite	DAILY & HOURLY OUTPUT(all figures are in mt)					
YEAR	1	2	3	4	5	6 to 10
Daily production (MT)	134	979	1609	2647	1966	2055
Hourly production (MT)	15	109	179	294	218	228
OB + Waste	DAILY AND HOURLY OUTPUT(all figures are in mt)					
OB and waste generation (MT)	95	41	62	167	90	79
Hourly OB and waste	11	5	7	19	10	9
Total material handled per day (MT)	**229**	**1020**	**1671**	**2814**	**2056**	**2134**

6.7 Method of Operation

The type of mining is strip mining under the opencast classification of mining. The method of mining will be semi-mechanized where primary breakage will be done by rippers secondary by the rock breakers and loading will be done by excavators. Tippers/dumpers will be used for transportation of the boulders to the stockyard and muck to the waste dumpsites.

Other works such as the road maintenance and environment management and will be done by the machine and labor combination. On the whole the disposal of the materials (rocks and muck) will be done by load-haul-dump method.

As the deposit is seen to exist almost continuously with a generally uniform dip and strike the nature of occurrence offer greater advantage to the company to conduct mining operation on a continuous basis. Therefore, mining during all ten years of operation will occur as a continuous process.

CHAPTER 7: WASTE DISPOSAL PLANNING

7.1 Location.

The OB and quarry waste dumpsite is located at north-east section of the quarry near and between DP8 and DP10. It lies at lead distance of 600m from the top first bench and 0 to 50m from the final bench of the tenth year. This means that it is at the average lead distance of 325m from the quarry pit.

7.2 Method of Waste Disposal

The general method of waste disposal, i.e. load-haul-dump will be practised for disposing mine overburden in the location mentioned in Section 7.1. The mine overburden generated will be loaded on to the tippers by wheel loaders and carried to the lowest level, i.e. near the dumpsite gabion wall and dumped advancing upslope. After every fill of 1m thickness compaction will be done by machines marching over it. When the wall is filled at its height level a 5m width bench will be maintained. Likewise series of benches will be maintained upwards maintaining the width and height of 5m and compaction done at every 1m fill.

7.3 Treatment of Waste and Management of Waste Dump and its Stability

The only waste that is going to be generated from the quarry is the soil and the weathered rock in the quarry area. So, it is expected to have a lot of dusting problem in the dry seasons, which will require wetting of the waste dump by spraying water.

The onward operation is going to generate very less quantity of overburden. The only measures to be taken will be mostly on the overburden already dumped. The new overburden dumpsite has already some muck in it which was pushed from the earlier operation of the abandoned benches and the access road cutting.

Any other form of waste, including muddy water, shall be drained by constructing proper drainage system.

CHAPTER 8: MANPOWER

8.1 Manpower Requirement

8.1.A REGULAR MANPOWER:

The quarry will be operated by SMCL's site office. The office will be run by a team of managerial, technical and support staffs. Following will be the officials of the office.

1.	Mines Manager	1
2.	Mines Foreman	1
3.	Sales Executive	1
4.	Mines Supervisor	2
5.	Sales Assistant	1
6.	Adm. Assistant	1
7.	Trip Recorder	2
8.	Driver	1
9.	Guard	2
10.	Office caretaker	1
	Total	13
	Managerial	4
	Technical	3
	Support	6

8.1.B CASUAL WORKERS:

The method of quarry operation is termed semi-mechanized. However, very less labourers requirement has been felt by the company so far. Very few daily wage workers have been engaged in the areas such as the site office, road maintenance, overburden dumpsite and the stone crushing plant, if established. On the average there will requirement of 3 to 5 casual workers for the aforementioned works, other miscellaneous works and to assist the regular staffs in their day to day jobs.

CHAPTER 9: CAPITAL COST

9.1 Preliminary Studies

It is a capital cost incurred for explorations works, environmental and social studies, deposit assessment in terms of quality and quantity with topographical survey and preparation of the project report. The cost is mostly the DSA, mileage or hiring of vehicles and study tools/devices as the studies were done departmentally by SMCL.

Sl.No	ACTIVITY	COST
1	Reconnaisance study	55,000
2	Travel and site visits	26,500
3	Survey, Geological and FMFS	264,000
4	Sample collection and testing	14,750
5	Incidental and contigencies	10,000
	TOTAL	370,250

9.2 Pre-production

All overhead and maintenance expenses during the development phase of the projectis covered under the pre-production activity, which is a working capital expenses.

Therefore, the following expenses shown in the table for 6 months is booked under the pre-production. The development phase is expected to be completed in 6 months after the commence of the development works.

Sl.No	ACTIVITY	Months	COST
1	Salary & Wages(@Nu. 20,000/m ave. for 5 staff	6	1,560,000
2	Hand tools and field equipment	6	26,000
3	Adm & General Overheads	6	78,000
4	Daily Wages(10 persons)	6	165,000
5	EME hiring	6	17,430,530
6	Office and store on rent	6	132,000
	TOTAL		19,391,530

9.2.1 EME HIRING

SMCL shall deploy machines and tipper/dumpers at the quarry on hiring basis. However, the hiring cost of the machines and tippers for 6 months, i.e. during the development period will be booked under capital expenses as the cost is incurred

during the project phase. Since it is like a service purchased it shall be amortized in the accounting processes.

SN	Particulars	No of EMEs	Working Hr/Day	No of days	Rate/Hour	Operation Month	Total Amount
1	Excavator	3	9	25	1745	6	7,067,250.00
2	Rock Breaker	0	9	25	1849	6	-
3	Ripper	0	9	25	1749	6	-
4	JCB bakhoe loader	1	9	25	800	6	1,080,000.00
5	Tippers	20	9	25	440	6	11,880,000.00
6	Water tanker	1	9	25	440	6	594,000.00
7	Wheel Loader	1	9	25	1550	6	2,092,500.00
	Total						**22,713,750.00**
	Total after 23.26% less due to EME breakdown and delay in deployment						**17,430,531.75**

9.2.2 OFFICE AND STORE

SMCL will not build office or staff quarters or store or guest house. It shall be taken on rent basis from the nearby villages of Tading and Lower Tading. It also becomes like act of CSR in the community from which the local people can make some income. However, expenses for taking flats on rent for use as office and store during the first 6 months shall be booked as capital expenses.

1. Office : Nu. 10,000/month = Nu. 60,000.00
2. Store : Nu. 5,000/month = Nu. 30,000.00
3. Guest House : Nu. 7,000/month = Nu. 42,000.00

Total = Nu. 132,000.00

9.3 Office Equipment

	Particulars	Quantity	Cost/per	Amount
1	Office Equipment	7	50000	350,000
2	Office Furniture and fixtures	7	10,000	70,000
3	Diesel Generator	1	500,000	500,000
4	Others			100,000
	Total			**1,020,000**

Office equipment such as computers and peripherals, telephones, fax machines, xerox copy machines, furniture and other necessary items were purchased.

The office equipment in the table above is inclusive of computers and peripherals. Also a diesel generator will be purchased for use to supply power to the office and the weighbridge as back up when there is power shutdown.

9.4 Vehicle

A light vehicle, 'Bolero', shall be purchased for used as pool vehicle at the site office. For the easy smooth movement of the staffs 3 motor bikes shall be purchased; one each for the Mines Foreman and the two Mines Supervisors.

	Particulars	Quantity	Cost/per	Amount
1	Bolero	1	750000	750,000
2	Bike	3	100,000	300,000
	Total			**1,050,000**

9.5 Access Road

Two stretches approach road of total distance of 2.9km from the Tading farm road till the boundary of the quarry has to be constructed. From the boundary another 0.9km of access road will reach to the top section of the quarry. A total of 3.8km of total new road shall be constructed.

	Particulars	Length	Nu./Km	Amount
1	Road	3.7	7700000	28,490,000
	Total			**28,490,000**

9.6 Gabion Walls

The gabion wall will be constructed at the base of the OB dumpsite, along DP8 to DP10 before the commencement of the development of the OB benches. Due to space constraints instead of series gabion walls that may be needed in the future onetime RCC wall may be opted. Currently 1 gabion wall of 1m x 1m cross section with 85m length is considered to overburden generated during the initial years.

	Particulars	No.	Length	Nu./Km	Amount
1	Wall	3	85	16400	4,182,000
	Total				**4,182,000**

9.7 Other Capital Costs

SN	Description	BoQ Amount	Location
3	Drinking water	1,570,734.66	Above quarry site
4	Jungle clearings	1,367,045.22	Quarry and crusher site
6	Demarcation of quarry boundary	66,523.39	Quarry
7	Ammunities & hutments	610,628.12	Quarry
9	Weigbridge and accessories	2,042,383.27	Lower Tading
	Total cost	**5,657,314.66**	

9.8 Estimated ERB

The ERB as required by the DGM for the mine area and the total overburden in cubic meter has to be deposit before the mining lease is renewed. This capital cost is calculated below as per the DGM's formula.

Sl. No.	Particulars	Quantity	Unit	Rate (Nu.)	Total (Nu.)
1	Area	14.88	Hectare	15,000	223,200.00
2	Overburden	255,014.39	CUM	5	1,275,071.95
				Total	**1,498,271.95**

The ERB in the table above is calculated in line with the following formula:

ERB=Ax+By+Cz, where;

A = Area in hectares
B = Total OB in m^3
C = Mineral production in MT
x = Nu. 15,000/hectare for this mine
y = Nu. 5/m^3 of OB
z = Nu. 4/mt of quartzite

The ERB to be deposit at the issuance of the mining lease by DGM is Ax + By. Cz shall be paid during the production phase of the mining life.

CHAPTER 10: PRODUCTION COST

10.1 Stripping Cost

The mode of operation of the quarry is by deploying hired earth moving equipment. Following EME will be deployed at the quarry.

1) Excavator : 3 Nos.
2) Ripper : 1 No.
3) Rock breaker : 1 No.
4) Backhoe loader : 1 No.
5) Wheel loader : 1 No.
6) Water tanker : 1 No.
7) Tipper : 20 Nos.
8)

Annual stripping cost:

	Particulars	No of EMEs	Working Hr/Day	No of days	Rate/Hour	Operation Month	Total Amount
1	Excavator	3	9	25	1745	12	14,134,500.00
2	Rock Breaker	1	9	25	1849	12	4,992,300.00
3	Ripper	1	9	25	1749	12	4,722,300.00
4	JCB bakhoe loader	1	9	25	800	12	2,160,000.00
5	Tippers	20	9	25	440	12	23,760,000.00
6	Water tanker	1	9	25	440	12	1,188,000.00
7	Wheel Loader	1	9	25	1550	12	4,185,000.00
	Total						**55,142,100.00**
	Total after 23.26% less due to EME breakdown and delay in deployment						**42,316,047.54**

10.2 Transportation cost

The tippers under the stripping cost in 10.1 are exclusively for OB/muck disposal. Therefore additional tippers shall be required for transportation of boulders to the stockyard in Lower Tading at distance of about 4km.

Annual transportation cost:

Sl. No.	Particulars	Quantity (MT)	Rate	Amount
1	Transportation	518,300	50	**25,915,000**

10.3 Fuel, Water, Power, Telephone and Internet

Fuel will be consumed by the diesel generator, the pool vehicle and the 3 motor bikes. The other machineries and heavy vehicles will be deployed on hiring basis and the fuel prices will be included in the hiring costs. Water will be sourced from the company's source at the north-west of the quarry. Therefore, only the charges for the utilities such as electricity, telephone and internet shall be paid.

Annual fuel and utilities costs:

	Particulars	Qty	Unit	Rate	Total Amount
1	Fuel	5910	Lt	52	307,296
2	Electricity	2000	Month	12	24,000
3	Telephone	2000	Month	12	24,000
4	Internet	1000	Month	12	12,000
	Sub Total				**367,296**

10.4 Repair and Maintenance

Annual maintenance costs:

	Particulars	Total Amount
1	Office equipment	35,000
2	Office furniture and fixtures	7,000
3	Vehicle	75,000
4	Bike	30,000
5	Road	2,849,000
6	Gabion walls	418,200
7	Dringking water	157,000
8	Demarcation pillars	6,600
9	Ammunitis and hutment	61,000
10	Weigh bridge	200,000
	Sub Total	**3,838,800**

10.5 Office and Store

SMCL will not built office or staff quarters or store or guest house. It shall be taken on rent basis from the near by villages of Tading and Lower Tading. It also becomes like act of CSR in the community from which the local people can make some income.

1. Office	:	Nu. 10,000/month	= Nu. 120,000.00
2. Store	:	Nu. 5,000/month	= Nu. 60,000.00
3. Guest House	:	Nu. 7,000/month	= Nu. 84,000.00
Total annual			= Nu. 264,000.00

10.6 Health, Safety and Sanitation

Health and safety of the staff and the laborers are the priority of the firm. Healthy workers are efficient thus resulting to better performance and eventually better return to the company. Health, safety and sanitation shall be in place as per the provisions of the labor and mining rules.

The nearest medical facility available is at Phuntsholing Hospital. To provide basic medical care to workers a First Aid Kit will be provided at site for minor injuries and common seasonal illnesses while proper medical facilities will be availed from the hospital. Workers will be provided with protective masks and dust collection apparatus to prevent workers from infection of dust borne disease. Other personal & safety gear to be provided to workers is given below

1. ear mufflers,
2. ear plugs,
3. mouth respirators,
4. dust arresters, rain gear,
5. Head gear/helmets and boots.
6. gloves

Budgetary provisions shall always be kept on annual basis for the purchase of medicines and replacement of the worn out personal and safety gears.

	Particulars	No.	Unit Cost	Total Amount
1	Safety gears	18	10,000	180,000
2	Health check	18	500	9,000
	Sub Total			**189,000**

Annual Safety and Health Cost:

10.7 Marketing and Promotion

Another area of major expenditure is the expenses incurred in the marketing of the mining products. Nu.250,000 is being budget for annual travel to for market studies of quartzite boulders and aggregates in the neighbouring countries and within the country.

Annual Marketing Cost:

Sl. No.	Particulars	Amount
1	Marketing and Promotion	**500,000**

10.8 Government Levies

The Royal Government recently revised the Royalty and Mineral Rent for export of minerals including the construction materials. The revision is based on the ad valorem of 2% Royalty on the minimum floor price and Mineral Rent of 10% on the Royalty. Currently the minimum floor price for export of boulders is Nu. 405. The minimum floor price is subject to change with time.

Annual mineral levies and taxes: Royalty

Sl. No.	Export	Quantity (MT)	Rate	Amount
1	Royalty	518,300.00	8.10	4,198,230.00
2	Mineral Rent	518,300.00	0.81	419,823.00
Total				4,618,053.00

ERB

Sl. No.	Particulars	Quanty (MT)	Rate	Amount
1	**ERB**	**518,300**	**4**	**2,073,200**

10.9 Annual Overhead Costs

10.9.1 SALARY AND WAGES

SMCL will have 13 regular and 5 daily wage staffs comprising of managers, technical and administrative support crew at the site office.

Annual salary:

Sl.No.	DESIGNATION/POST	NO.	RATE	Months	COST
1	Mines Manager	1	55,000	12	660,000.00
2	Foreman	1	20,000	12	240,000.00
3	Adm	1	18,000	12	216,000.00
4	Mines Supervisor	2	15,000	12	360,000.00
5	Sales Executive	1	24,000	12	288,000.00
6	Sales Assistant	1	19,000	12	228,000.00
7	Driver	1	9,000	12	108,000.00
8	Trip Recorder	2	10,000	12	240,000.00
9	Guard	2	9,000	12	216,000.00
10	Caretaker	1	8,000	12	96,000.00
11	Daily wage	5	6,750	12	405,000.00
	TOTAL annual PAYMENT	18	187,000		3,057,000.00

Annual benefits: LTC, Leave Encashment, Performance Allowance and Bonus

Sl.No.	DESIGNATION/POST	NO.	RATE	215%+LTC
1	Mines Manager	1	55,000	133,250.00
2	Foreman	1	20,000	58,000.00
3	Adm	1	18,000	53,700.00
4	Mines Supervisor	2	15,000	47,250.00
5	Sales Executive	1	24,000	66,600.00
6	Sales Assistant	1	19,000	55,850.00
7	Driver	1	9,000	34,350.00
8	Trip Recorder	2	10,000	36,500.00
9	Guard	2	9,000	34,350.00
10	Caretaker	1	8,000	32,200.00
11	Daily wage	5	6,750	0.00
	TOTAL annual PAYMENT	18	187,000	552,050.00

CHAPTER 11: ENVIRONMENTAL MANAGEMENT PLAN

11.1 The Environment

The Land Environment

The quarry site is located at crow-fly distance of about 1km both from the upper and lower Tading villages. It is in north-west direction from the villages. It falls completely in the State Forest Land and is partially forested in the upper section and thickly in the lower. The area is mostly rocky with thin soil cover, i.e. at maximum of 5m in certain areas at the tope section. To the north-east side there is a major existing landslide, which limits the quarry boundary toward it.

Soil Characteristics

There are two types of soil in the quarry area. The residual sandy type forms mostly upper part of the quarry area. In the middle and the lower part the soil type is matrix of sandy to loamy to loamy. The gentle area part in the middle and lower section of the quarry contains colluvial deposit of mostly loamy type of soil, which is dark in colour due to dead organic matter content.

Air Environment

The major source of air pollutants in the quarry will be the vehicles and machines emissions. Dust generation will also contribute to change in the air quality especially during the operational phase of the quarry and in the dry seasons. The current status of the air environment has to be at the natural state as the site is located in the uninhabited forest. The air quality assessment was not carried for Kharbari Dara Stone Quarry due to the time constraint. However, the company was fortunate to get the environment baseline data of stone quarries, which were very recently approved and are located nearby and experiences same climatic conditions.

Water Environment

The quarry area is flanked by two water bodies. The are Purbay Kholsa stream in the south west and Tarika Kholsa at the north-eastern direction. Both are seasonal streams and they become of stream to rivulet size only during the monsoon. The Purbay Kholsa is the only concern with respect to Kharbari Dara Stone Quarry as it lies directly below the south-west facing slope of the quarry, although it is more than the allowable distance from the quarry boundary.

Noise Environment

The ambient noise at the site during day was recoded using the software Decibel X on the iPhone. It is a highly reliable software and comes pre-calibrated. The following noise levels were measured on the Decibel X metre and recorded as in the table below.

Morning	Afternoon
47 dB(A)	49 dB(A)

The Biological Environment

A broad picture of the proposed quarry of the floral dominance was obtained through literature review and past studies conducted in the surrounding areas of the quarry site. The general vegetation recorded in the area as per earlier studies conducted is given in the EIA report.

The trees in the quarry site ranges in heights of 5 to 20m, with varied thickness. The tree density including both big and small estimated in the quarry area is around 250. The under-growths are thick and covered with numerous shrubs and herbaceous plants.

11.2 Socio-economic Environment

A team was deployed to conduct the socio-economic study in the nearby villages. There are only two villages in the locality, viz. Upper Tading and Lower Tading. The team interviewed 8 people of 8 households, viz. Arjun Kumar Tamang, Jaman Singh Tamang, Krishna Tamang, NB Tamang, Samar Tamang, Suk Maya Tamang, Sunita Tamang and Tek Bahadur Chettri.

It was learnt that the source of income for the two villages were from the sale of agriculture produces such as vegetables, cardamom, cash crops, oranges, etc. These items are cultivated or produced only in small quantities and are sold in Phuntsholing market which is about 15 to 20km away. The other source was from the relatives employed in the private companies and civil service.

11.3 Quarry Wastes

There will be two types of waste generated in the quarry. The overburden, usually soil and phyllite, and the inter-burden (mostly phyllite) shall be considered as they are unwanted and needs to be properly disposed in the pre-identified dumpsite. The other waste shall be the solid and other kitchen waste from the workers and staffs.

The stone quarry will produce about 250,000 MT of quarry waste in 10 years, out of which about 100,000 MT will be the soil and talus. Compared to the quartzite to me mine during the period the waste is 20 times less. The quarry waste does not have any toxicity. The only risk may be due to silica in the quartzite that if contaminates fields will reduce the soil fertility. However, the quartzite in Kharbari Dara is greyish type and has very less silica content and moreover the agriculture fields are far away separated by mountain depressions and ridges.

11.4 Sensitive Receptors

The quarry area does not fall under any of the categories of protected areas, Wildlife Sanctuary, National Park, and Biological Corridors, archeological sites, critical watershed, settlements, important installations and sites of historic, cultural and religious importance. The only public infrastructure is the farm road the nearest point of which is at about 1km crow-fly distance from the quarry. The only sensitive receptors may be identified as in the following:

a. Villagers of Upper and Lower Tading
b. Commuters of the farm road
c. Wild animals
d. Aquatic lives

11.5 Existing Infrastructure

There are no infrastructure present in or near the quarry area other than the Tading farm road. The nearest settlement is Tading village which is located at around 1 km radius (aerial distance) in south and south-east from the proposed quarry area.

11.6 Public Consultation

The community consultation meeting was done with the representatives of Tading community on 6th of December, 2017 as per Article 16 of the EA Act 2000, and section 31 of the Regulation for Environment Clerance of projects 2002. The list of the participants with the minutes of the consultations are attached in the appendices. The public consultation was conducted twice as there was some divided views on the quarry during the first one. Out of 42 people in the consultation meeting 4 were not in favour of the quarry despite SMCL agreeing to their concern. As the Gewog

Tshogde was not able to endorse the conultation minutes, even though the people against the quarry did not have any concrete reason, the DLLC intevened to conduct the second round during which all cleared the quarry.

11.7 Concerns of the Public Agreed by SMCL

Drinking Water

The first concern of the public was that their drinking water source was not to be disturbed. The drinking water source lies far from the quarry site in the directin of north-west of the quarry. Al though it will not be harmed by the quarry operation, SMCL as CSR will proivide hand in its repair and maintenance.

Dust

To ensure dust generation does not have impact on the people of the communities and their property. The people were ensure that there shall be no impact on them or their property due to dust from the quarry operation, including the vehicle movements.

Agriculture

To ensure the productivity of their cultiations are not affected. In the event it is affected the people were convenced that compensations will be paid.

Road

The proposal of the road through the lower Tading village was denied, although they had allowed the other mining promoters. It was agreed that the approach will be taken along the right bank of the Purbay Kholsa stream, as suggested by the people.

Land Environment

The Topography

The main impact on topography will be due to cutting of trees and clearing of bushes, construction of access roads and internal haul roads and quarry benching. Stripping of overburden and disposal, storing topsoil, benching and loading points development will bring visible changes in topography of project site. Unintentional rolling of excavated materials will also cause erosion.

In the operation phase, the impacts on topography will be visible due to presence of benches, access road and internal road and dumping of quarry waste. These changes in topography will be only till end of the project life.

The thickness of the soil cover is of about 5m only in the supper section of the quarry. Although the topmost part of the quarry is hillock type the hill slopes gradients are relatively medium. So, overburden bench development during the monsoon would result to mud flow down the slopes causing soil erosion.

No other impact such as the slope instability is anticipated as the quarry area is in stable rocky zone of quartzite.

Land Use

The quarry area of 36.764 acres falls in the State Forest Land. Initially it used be Sokshing, as claimed by the people of Lower Tading. There are few fallow private lands below the lower boundary of the quarry. The land owners are positive about the quarry as quarry road is going to pass near their land.

Soil Erosion

One of the impact identified is soil erosion due to removal of topsoil and vegetation during the construction activity and overburden bench development. There may be occasional mudflow when there is heavy rainfall. However, this is likely only during the overburden bench development. Once the overburden benches are stabilized and benches are on the hard quartzite the impact will be very minimal.

Visual Impact

Once the vegetation and quarry benches are developed the site will be visible in the form of a scar. The site is partially visible from Phuntsholing and very well seen from

the plains in India. Its clear visibility is due to the location. It is located on the mountain hill slope facing south.

Air Environment

Any quarry activity will have some negative impacts of varying degree, some of which are inevitable. The main source of air pollution due to the stone quarry operation are dust particulates and gaseous pollutants from movement of vehicles, operation excavation and other earth moving machineries.

Given the same mining area, the stone quarry will not require as many excavators and other machines as required by other mines due its stripping ratio. Therefore, the number of machines required less will have less impact to the air in terms of emissions and dust generation. The other fact is that ripper will be used in placed of explosives for primary extraction of the quartzite boulders. Rippers are more efficient in terms of production and less harmful in terms of dust generation.

Water Environment

Again, the topography is the main factor in this section also. Purba Kholsa stream lies at the bottom of the medium to steeply sloping south-west facing hill slope. At the initial stage of the lease period the quarry bench configuration is toward the Purbay Kholsa stream. As per the quarry designer it was done so as to accrue maximum bench width to win more benches when the quarry face direction is changed toward south-east at the lower section of the quarry. Therefore, it is likely that the surface run-off water will carry debris toward to stream. But it is also likely that it will not reach the stream due to the slope distance and the vegetation down slope.

Surface Water Sources and Quality

The quarry area does not contain surface water source as such. However, during rainfall the surface run-off water must get collected in the natural depressions and gullies and drain into the streams in the lower levels on the both sides of the quarry area. Currently there is no landslide or erosion taking place in the area. During the quarry operation, especially in the monsoon time, the run-off water will collect eroded and dissolvable particulates and contaminated water will flow into the streams below.

Ground Water Sources and Quality

There is no ground water source in the area. The geologists during there geological investigation of the site, was given task to study the presence of the sources such as spring water in and around the quarry area. It was reported that there was no sign or presence of any water flowing from underground.

Noise Environment

Noise is a primary concern in the quarry projects. Noise pollution from quarrying operation is caused during drilling, loading and unloading, transportation and crushing, etc, This often leads to occupational hazards and causes annoyance to the local community. In additional to noise, another environmental and social repercussion of quarrying projects is the ground vibration during blasting or from the use of ripper, which causes significant impact and causes direst loss to property such as cracks in houses and sometimes it may lead to collapse of temporary or permanent structures close to quarry, but the quarrying in this proposed project do not choose to use blasting techniques for rock breaking. A high-tech machine called ripper will be used for primary extraction of the quartzite boulders from the bedrock.

The impact on ambient noise level due to rock excavation, transportation and ancillaries lies within the safety working hour limit. The effect of it is minimal and will be felt only by the workers in the quarry area.

Biological Environment

Impacts on Flora

The quarry project is located in the State Forest Land area. It is partially forested in the upper area and medium to thickly forested in the lower. About 60% to 70% of the total forest in 36.764 acres of quarry will be deforested in 10 years or mining lease period. There will be loss of trees and the vegetation will be destroyed. The flora will be disturbed at access road also by dust from the movement of heavy vehicles.

Impact on Terrestrial and Aquatic Environment

The quarry operation will displace the wild animals, birds and insects from the area, which was their habitat. This will result in the loss of biodiversity and ultimately have effect in the ecosystem of the region. Therefore, it will be untrue that a mining project will not have impact on the terrestrial environment.

The impact on aquatic environment is seen minimal due to the operation of the quarry. The quarry is located far from the streams and river and is separated by thick vegetation. There will no flow of sediments into the water bodies except for some turbidity. However, if mining is not carried out in a scientific manner, in the long run, minor soil erosion at the site may trigger landslides and slope movement, which will have negative effects on the streams and rivers below.

Impact on Wildlife Including Avi-fauna

The quarry area is not located in any protected areas. The impacts identified are disturbance to wildlife in the area and surroundings due to operation of the quarry and its related activities. However, being small area the disturbance to wildlife will not be felt at longer distances.

Impact on Wildlife Habitat and Migratory Route

There is no migratory route for wildlife in the quarry or nearby areas. Therefore, the mining and allied activities will not have any impact on such species of animals that do need to migrate across the quarry area.

Impacts on Flora and Fauna Due to Quarry Activities

The emissions of dusts in the air from construction of access roads, of quarry activities and plying of vehicles to transport materials will have impact on flora, fauna and avi-fauna in the core area and surroundings.

The noise may be generated from operation of machinery, moving of vehicles and use of other earth moving machines. The impact identified is the disturbance to local wildlife due to vehicular traffic and vehicular noise. The vibration form rock breaking and from the use of ripper may impact flora and wildlife. The wastewater from cooking, washing, toilets and washing vehicles will flow into streams and rivers, which will affect aquatic life.

11.11 Socio-Economic Environment

People from community will have opportunity to seek gainful employment, depending on their skills and experience. Any construction activities in the nearby village will have readily available stones due to the presence of the quarry nearby and perhaps a crusher in the near future. The people will also be given contract works of size of their capacity. Villagers can also grow and sell farm products to the staffs and workers of the quarry.

Al though the communities will be directly or indirectly benefited by the quarry operation, especially in terms of income generation the possibility of social issues that may arise cannot be ruled out. Preference for job and works will be provided to the communities but there will be still staffs and workers from other places and countries with different cultures. Influx of such people in the such remote area may inflict harm to the society of the communities.

11.12 Quarry Wastes

The quarry wastes and overburden if not managed in properly and but handled in a haphazard manner will have end number of impacts on the environment, including the human settlements down stream. It will result in soil erosion, land degradation due to landslide and possibly triggering mass movement. The flow of sediments and siltation in the downslope areas may result in the de-fertilization of the agriculture lands, thus decreasing the yields.

11.13 Sensitive Receptors

Four sensitive receptors were identified as the villagers of the nearby communities, the users of the farm road, wild animals including birds and the aquatic lives. The four categories of impact receivers in oneway or the other likely to be affected due to the quarry operation. The possible sources of hazards are land degradation, air pollution, water contamination, etc. and the risks involved are generally loss of property, diseases, reduced agricultural produces and loss of biodiversity.

11.14 Existing Infrastructures

There will be no impact on the infrastructures since there are no private or public infractures in or around the proposed quarry site. However, there will be impact on the farm road becasue of the increased users.

11.15 Mitigation Measures

Environment Management Plan (EMP) and the Mitigation Measure are the tools to act against the adverse effects detected against the environment receptors of a project identified and described in the environment assessment process. They would be of initial implementation, progressive in nature, i.e. through out the project life or taken up at the end. The plan will describe a system in which the mitigation measures can be implemented in an effective manner. The following mitigation measures shall be the part of the EIA process which shall be detailed out in the EMP.

Land Environment

The environment management plan actually starts at the stage of mine planning. The quarry benches are designed in such a way that the operation would have minimal impact on its environment. Cost analysis is done to see the breakeven between the revenue generated and the cost of management of the environment damaged to gain access to the rock for utilization to generate revenue.

In the case of Kharbari Dara Stone Quarry quarry benches start from a hillock like landform at topmost section of the quarry. This provides enough working bench width through the 10 years proposed lease period. Deployment of any machine or dumper size suitable for effective operation and environment management is possible. Slope instability is therefore not an issue and bench failures will not occur.

However, during the monsoon the benches at the top section, during the first two years of operation, will be maintained with extra vigilance as the removal of soil is mostly involved. Load-haul-dump of the overburden will be strictly followed. Drains shall be made at the toe of the benches. Garland drains shall be made in the periphery of the quarry pit and the overburden dumpsite and French drains in the barren area to catch the surface run-off water.

Technological Measures to Prevent Soil Erosion

Gabion Wall at the First Bench

In a open strip mining the backslope (highwall) of the first bench is usually irregular in shape and of unacceptable height. As it is additional capital investment the risk of slope failure is ignored, which if occurred is the starting of all problems. Therefore, a gabion wall will be constructed at the toe of the first bench in the stretch of the highest backslope.

Cut and Fill Method

The topsoil and excavated materials shall be used on the roads and ramp construction only. This will prevent dozing of the material during the road cutting. Also it shall be used for filling gentle depressions to give wider road width. The remaining material (muck) shall be dumped in a pre-identified and suitable place.

Runoff control through proper drainages

The side drains will be constructed to divert surface runoff from mine area and overburden dump areas. The surface drains will divert surface runoff, reduce volume of surface water, reduce water pollution, and prevent surface erosion. The side drains will be constructed along the haul road and side drains around the overburden dump area.

Plantation/Afforestation

The compensatory plantation/afforestation will be carried out in mined out benches, dump areas, labour camps and stockyard. There will be clearing of 60% of the forested lease area for mining activity. The plantation will be carried out to compensate for the loss of forest. The benches will be prepared for mining. Once the benches are mined, the plantation will be carried out in the succeeding year. The topsoil will be filled on mined out benches and compacted. The overburden waste will be compacted by heavy earth moving machinery after each successive layer of 5 m. Once the dump height reaches 5m, a gap of 5m is maintained to ensure stability and vehicle movement. The dump areas will be filled with topsoil.

Landscaping, Plantation and Afforestation

The benches will be constructed to extract boulders. Once the boulder extraction is completed, the topsoil shall be back filled into the preceding mined-out benches. The benches shall be re-vegetated by planting sapling suiting the climatic conditions and is fast growing. The overburden waste will be compacted by heavy earth moving machinery after each successive layer of 5m. Once the dump height reaches 5m, a gap of 5m is maintained to ensure stability and vehicle movement. The overburden waste will be again dumped and compacted. The dump areas will be filled with topsoil and plantation will be carried out.

The site office and labour camps and stockyard will be cleared after 10 years of mining operation. The area will be filled with topsoil, compacted and rehabilitated with local plant species.

The plantation and afforestation of mined out benches, overburden dump areas, site office and worker camps and stockyard will provide green landscape, therefore minimize visual impact.

Method of Disposal

Topsoil will be scrapped, transported and stored in 10 years of mining. The topsoil will be back filled on mined-out benches and overburden dump areas. The benches shall be re-vegetated by planting plant species.

Gabion wall will be constructed at the lower end of dump areas to maintain stability of dump areas, avoid erosion and check surface runoff downstream. The dimension of the gabion wall will be 1m x 1m x 85m. The gabion wall will consist of rectangular units fabricated from galvanized steel wire mesh and filled with clean, hard and unearthed stone.

The overburden waste will be loaded systematically, hauled to dump area and dumped in layers. The materials will be compacted by heavy earth moving machinery after each successive layer of 5m. Once the dump height reaches 5m, a gap of 5m is

maintained to ensure stability and vehicle movement. The overburden waste will be again dumped and compacted. The dump shall maintain 45° of angle of repose. The dump areas will be filled with topsoil and re-vegetated with plant species.

Air Environment

Dust suppression will be carried throughout the year at the quarry working face, approach and access roads, ramps and OB dumpsite. A dedicated water tanker will be deployed for the purpose. The vehicles and machineries will be maintained time to time to ensure emissions of acceptable level.

Water Environment

Drains will be constructed at the quarry benches, roads and overburden dumpsite to catch the surface run-off water for proper drainage. If necessary a de-siltation pond will be made to clean the muddy water before it is drained into the natural drainage system. Trees and bushes will not be unnecessarily cut but preserved to prevent soil erosion. The quality of the water in the streams and rivers shall be monitored frequently.

Noise Environment

Measures for Noise abetment

The much of the noise will be produced by the machineries, which will be limited to the quarry site only. SMCL approach will not pass through the village, therefore the noise due to movement of vehicles will be very minimal to the villagers. Use of explosive is being replaced by a ripper machine, which produces even lesser than a rock-breaker. Old machines and vehicles which makes extra noise shall not be deployed at the site unless repaired.

Biological Environment

Conservation and Rescue of Endangered Flora

The quarry area does not contain any endangered plant species. The Forest Officials were consulted about and moreover after their inspection for site verification for issuance of their clearance there was no reporting on the presence such species.

Conservation and Rescue of Wildlife including Avi-fauna

The project area is 36.764 acres SFL and not located in any protected areas. The impacts of disturbance to wildlife in the project area and surroundings due to construction related activities will not be felt at longer distances.

The quarry activity shall disturb a small patch of forests. There is a contiguous forest in the buffer area. The animal species will move to the buffer area which is enriched with forest as compared to proposed quarry area which will be degraded.

The mining activity should not allowed between 8.00 pm to 7.00 am to avoid disturbance to wildlife and birds as it will affect their movement, and the noise may scare the wild animals and birds. The plantation of fruit trees should be carried out to replenish damaged fruit trees, which are source of food for wildlife and birds.

The project management in cooperation with Department of Forests and Park Services should create awareness to mine staff and workers on forestry rules and regulation and penalty so that the staff and workers not indulge in poaching of wild animals and birds and resort to illegal felling of trees.

Conservation and Rescue of Aquatic life

Aquatic life will not be impacted directly by effluents and waste water as these are not drained to the river directly.

The project management in cooperation with Department of Forests and Park Services should create awareness to mine staff and workers on forestry rules and regulation and penalty and not to go for fishing in the river, The awareness will be given once the workers are mobilized and before the commencement of the project activity and shall be given two times a year since there will be change of workers.

There is no 'Zero Impact' when it comes to biological environment, impacts will always be there at some phase of the ecological cycle but the intensity of the impact depends on the sensitivity and location of the proposed area. There is nothing as 'best practice' for biodiversity mitigation. Similarly the mitigation measure also site and species specific, and have to be designed and implemented considering the ground realities.

Green Belt Development:

To provide an effective dust suppression and sight curtain the plantation programme has to be undertaken at the following areas.

- All along the pit foundry
- On the downwards slope of waste dumps along the banks of stream /water course
- Along the haulage road
- Waste dumps

The mitigation measures to rejuvenate the terrain thus mined, as well as to screen plantation and terrain greening and restoration, and protective plantation from sliding involves the plantation of local species on a regular basis. This will restore the greenery, vegetation, and control environmental impacts due to mining.

1.16 Socio-economic Environment

The actual activity of the quarry operation is confined only within 60% to 70% of the quarry area. There are no private lands or any form of agricultural activities within the boundary and as such the operation itself does not have any effect on the local setting.

However, the operation is expected to be long term and will bring employment and business opportunities to the local community.

- Dressing and stabilizing of abandoned benches
- Reclaiming, landscaping and soil grading and preparation of beds
- Carrying out immediate re-vegetation of the reclaimed benches in a systematic manner with locally available sapplings.

This activity will be taken up anually so that abandoned areas are stabilized at the earliest possible time frame and greenery is returned. In this case quarry operation is planned towards the upper section only as the lower section does not exhibit material presence.

11.17 Quarry Wastes

Management Plan for topsoil storage, conservation and utilization

Topsoil will be stripped and stored in 10 years of mining. During the initial stage of mine development, the topsoil shall be stored adjacent to overburden dump areas. As the benches progresses, the topsoil shall be back filled into the preceding mined-out benches and overburden dump areas. The benches shall be re-vegetated by planting plant species. The overall gradient of the terrian selected as the waste disposal yard is around 10 to 15 degree and with the provision of protective barriers adequate space will be created and will provide sufficient space to hold overburden and the waste generated. Due to the topographical condition, gabion walls will be provided at the bottom edges of ovebrurden dumpsite.

Formation/compaction of waste dump benches

The overburden waste will be loaded systematically, hauled to dump area and dumped in layers. The materials will be compacted by heavy earth moving machinery after each successive layer of 5m. Once the dump height reaches 5m, a gap of 5m is maintained to ensure stability and vehicle movement. The overburden waste will be again dumped and compacted. The dump shall maintain 45° of angle of repose. The dump areas will be filled with top soil and re-vegetated with plant species.

Completion of all bench drains, cross drains and side drains

Storm water drains, cross drains and side drains will be developed and completed before commence of mining. The bench drains will be developed after completion of excavation of overburden.

Re-vegetation of mine benches and waste dump benches

After the overburden excavation and stone extraction, the top soil will be back filled in the benches. Local plant species will be planted in the benches. This will minimize erosion by protective layer of vegetation on embankment slopes and along exposed surfaces. The storm water drainage channels will be constructed to drain runoff.

11.18 Risks and Disaster Management

The project needs to adopt Occupational Health and Safety measures in the mine operation. The project office should ensure availability of adequate numbers of personal protective equipment at site and availability of first aid kits at worker camps and mining site and training providing first aid knowledge to the workers should be

given before the start of the project. It is required to provide site-specific safety measures, which is also taken into costs and likely economic benefit. There is requirement of measures for proper storage and handling of chemicals and oil, provision of construction hats, facemasks, earplugs, gloves, etc to workers, provision of well-equipped first aid kits and health facilities and maintain OHS.

There will be no impact on the infrastructures since there are no private or public infractures in or around the proposed quarry site. However there will be impact on the mining road because of the increased users. There might be impact on schools and health facilities due to influx of people from outside .

A mine/quarry environment management is act of carrying out planned programmes to mitigate both foreseen and unforeseen impacts on the environment due to mining activities.

Mine Reclamation is a process of returning degraded mine site to a useful state through stabilization, decontamination, removal of abandoned facilities, and either re-vegetation or converting to another human use.

Both mine environment management and reclamation require consideration from the time mining is initiated to the time mine is abandoned. The restoration process explained below is such that at the end of the mine life it will facilitate economical and effective rehabilitation.

The benches operated will be abandoned and restored in a progressive and staggered manner. The following method as tabulated in the Table for 'Sapling, Fencing and Manpower' will be used to re-vegetated the abandoned benches. The type of saplings to be planted will be as per the advice of the concerned Territorial Divisional Office of the Department of Forest and Park Services and endorsement of the DGM.

Annual Reclamation Cost:

EME deployment under contract for mining will be used for the progressive restoration works of the quarry. Therefore, separate costing for the use of the machines and tippers in the progressive restoration works, such as the soil grading, is not needed to be shown. However, the following costs will be incurred.

Annual Cost of Fencing and Plantation:

MATERIAL COST						
ITEMS	POLES	SAPLINGS	NAILS	AMOUNT	25%	TOTAL COST
NO	1000	1000	50	kg		
UNIT COST	120	90	35	Nu,/kg		
MATERIAL COST	**120000**	**90000**	**1750**	**211750**	**52938**	**264,688**
MANPOWER COST						
A FENCING						
MANPOWER	NO	RATE		TOTAL COST		
Daily Worker	5	225		1125	562.5	1,688
B. PLANTATION						
MANPOWER	NO	RATE		TOTAL COST		
Daily Worker	10	225		2250	1125	3,375
TOTAL MANPOWER COST						5,063
OTHER MISCLL EXPENSES						150,000
TOTAL OF FENCING AND PLANTATION						419,750

Annual Manpower Requirement

10 persons will be required for fencing. A total of 5 persons will be hired on daily wage and deployed during the fencing for 10days of progressive restoration. Company already has 5 on daily wage. Another 10 persons will be deployed fully for plantation which will roughly take 10 days.
The company will employ a caretaker for to look after the wellbeing and growth of the saplings and also repair and mend the damaged sections of the fence.

COST OF CARETAKER	1 PERSON	12 MONTHS		86400		86,400

Quarry development costs involves two major activities, i.e. a) removal and relocation of overburden and b) exposing insitu bed rock and development of safe working benches for systematic and continuous stone extraction. The quarry development works will be carried out annually for the purpose of developing new benches.

In practice the volume of the material to be removed annually may differ but for the purpose of determining tentative cost and estimation an annual average volume has been computed based on the total volume generated in 10 years. This is done so that cost projections for annual waste & reject removal and relocation can be done.

Therefore, the ongoing mine re-development & overburden removal activity is an annual recurring expenditure and not as a capital expenditure.

The annual cost of casual workers involved in this activity is booked under daily wages for 5 persons. The EME under contract shall be used for the purpose and the EME costing is covered. Therefore, no separate costing is required.

11.4 Other Costs - Environment Restoration Bond fund

Environment Restoration Bond, a security deposit for restoration of the quarry, should be capitalized. However, the method of its collection being per metric tonne of material despatched, in advance, the cost is considered current cost except for advance amount, which needs to be deposited before the work order for the development works is issued, as determined in section 9.8 and 10.8 of this report. From the two types of collections the total ERB is as shown in the table below.

Total ERB Collection:

Sl. No.	Particulars	Quantity	Unit	Rate (Nu.)	Total (Nu.)
1	Area	14.88	Hectare	15,000	223,200.00
2	Overburden	255,014.39	CUM	5	1,275,071.95
3	Production	5183000	MT	4	20,732,000.00
				Total	**22,230,271.95**

The project will be funded by 60% equity and 40% bank loan. The equity will be provided by the shareholder as it is a new project. The 40% bank loan will be long term loan and it will be mostly utilized in the capital investment. The following table shows the cash flow and the PAT of the project, Kharbari Dara Stone Quarry.

For the purpose of accounting asset must be depreciated. The table below shows the annual depreciated rates of the assets such as the road, equipment, etc.

12.1 Depreciation and amortization

Depreciation and amortization is method of spreading the value of a tangible and intangible asset of a period of it useful life. The tale below shows the annual depreciation of the assets. The rates in the table below are from the annexure of Rules on the Income Tax of Bhutan 2001.

Services		Rate (%)	Annual Amortization
Preliminary studies	370250	10%	37025
Pre-production	1829000	10%	182900
EME Hiring	17430530	10%	1743053
Jungle Clearing	1367050	10%	136705
Demarcation	66520	10%	6652
Assets		**Rate**	**Annual Depreciation**
Office equipment	1020000	10%	102000
Vehicle	1050000	15%	157500
Road	28490000	3%	854700
Wall	4182000	3%	125460
Dringking water	1570730	3%	47121.9
Hutments	610630	20%	122126
Weighbridge	2040600	15%	306060

12.2 Cash Flow, CoP and PAT

The depreciated and amortized values of the assets and services are used in the analysis of the PAT as shown in the table below.

Cash Flow, Cost of Production and PAT:

Head	Kharibari Dara Stone Quarry Annual Cash Flow					
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6 to 10
Quartlte (MT)	40258	293769.02	428786.17	794241.35	589754.36	3083100.91
Revenue from Sale of product	26,167,700.00	200,497,356.15	345,976,639.08	597,631,867.82	465,952,571.85	2,557,688,150.39
Revenue from Sale of Quartize	26167700	200497356.2	345976639.1	597631867.8	465952571.9	2557688150
Quality Compensation	-	-	-	-	-	-
Operating Expenditure	57,890,516	87,090,568	104,030,302	145,214,701	126,931,038	665,010,818
Environment Protection cost	2,152,000.00	2,259,600.00	2,372,580.00	2,491,209.00	2,615,769.45	13,732,789.61
Surface Rent	23,528.96	23,528.96	23,528.96	23,528.96	23,528.96	117,644.80
Mineral rent	185,186.80	1,351,337.49	1,972,416.38	3,653,510.21	2,712,870.06	14,182,264.19
Royalty	1,851,868.00	13,513,374.92	19,724,163.82	36,535,102.10	27,128,700.56	141,822,641.86
Drilling & Blasting	-	-	-	-	-	-
Stripping Cost	42,316,000.00	44,431,800.00	46,653,390.00	48,986,059.50	51,435,362.48	270,035,652.99
Hiring Charges	50,000.00	52,500.00	55,125.00	57,881.25	60,775.31	319,070.39
ERB	161,032.00	1,175,076.08	1,715,144.68	3,176,965.40	2,359,017.44	12,332,403.64
Utilities: Electricity, Telephone, Internet	368,000.00	386,400.00	405,720.00	426,006.00	447,306.30	2,348,358.08
Safety & Protective Gadgets	189,000.00	198,450.00	208,372.50	218,791.13	229,730.68	1,206,086.08
Employee Benefits	553,000.00	580,650.00	609,682.50	640,166.63	672,174.96	3,528,918.52
Employee Remuneration	3,057,000.00	3,209,850.00	3,370,342.50	3,538,859.63	3,715,802.61	19,507,963.68
Marketing	500,000.00	525,000.00	551,250.00	578,812.50	607,753.13	3,190,703.91
Rent	264,000.00	277,200.00	291,060.00	305,613.00	320,893.65	1,684,691.66
Transport cost from Mines to stockyard	2,012,900.00	14,688,451.00	21,439,308.50	39,712,067.50	29,487,718.00	154,155,045.50
General Expenses	368,000.00	386,400.00	405,720.00	426,006.00	447,306.30	2,348,358.08
Maintenance Properties	3,839,000.00	4,030,950.00	4,232,497.50	4,444,122.38	4,666,328.49	24,498,224.59
EBITDA	- 31,722,816	113,406,788	241,946,337	452,417,167	339,021,533	1,892,677,333
Interest on loan	-	-	-	-	-	-
Depreciation	3,821,303	3,821,303	3,821,303	3,821,303	3,821,303	19,106,514.50
EBT	- 35,544,119	109,585,485	238,125,034	448,595,864	335,200,231	1,873,570,818
Tax	- 10,663,235.60	32,875,645.44	71,437,510.15	134,578,759.12	100,560,069.18	562,071,245.50
PAT	- 24,880,883.06	76,709,839.36	166,687,523.68	314,017,104.62	234,640,161.41	1,311,499,572.82
Cost of Production	1,437.99	296.46	242.62	182.83	215.23	215.70

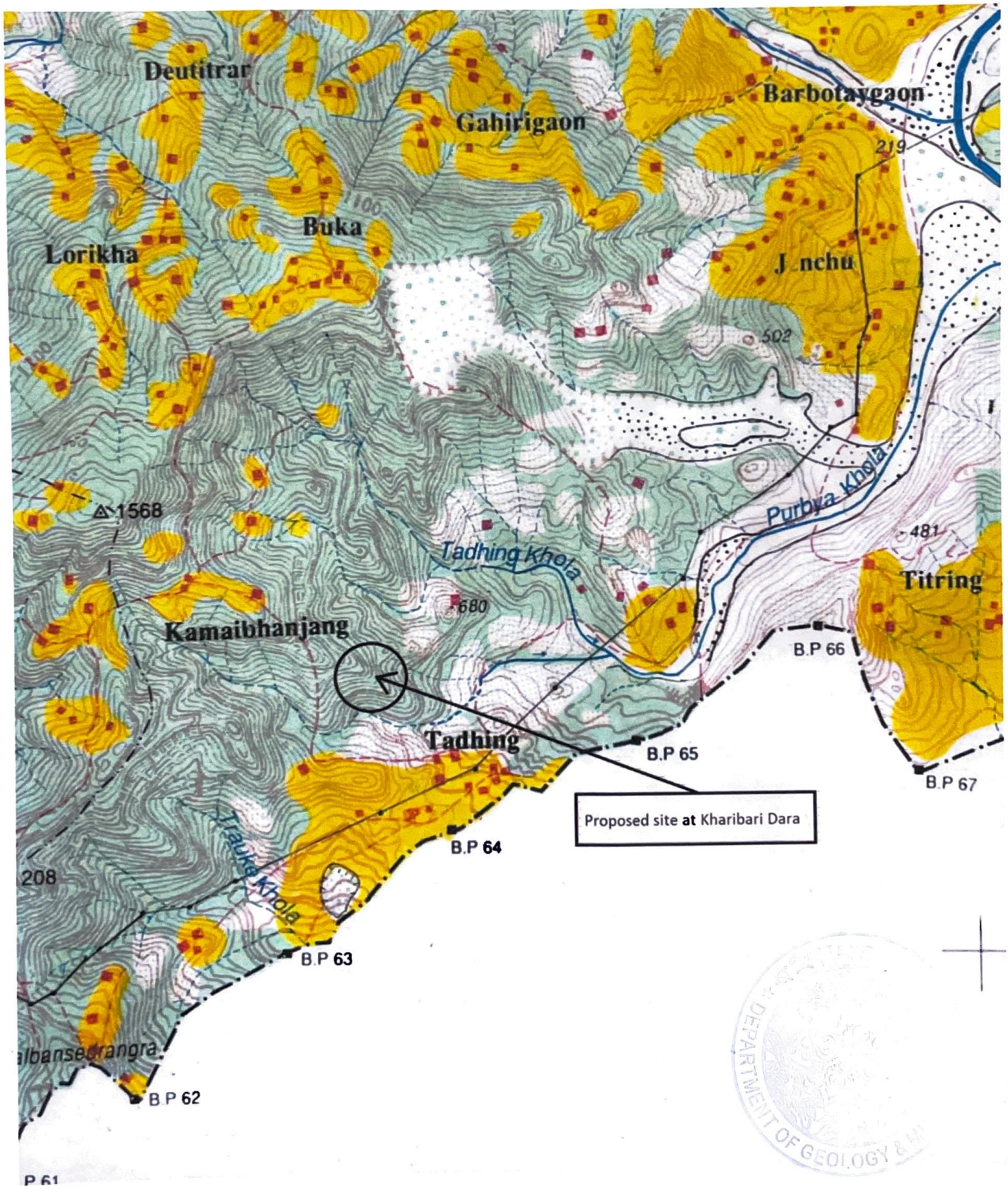
The table shows the company will suffer a loss of about Nu. 2.5 million in the first year of the quarry operation. Profit will be generated from the second year. The cost of production is high in the first year because of the comparatively high volume of OB to be handled and less quartzite output.

ANNEXURES

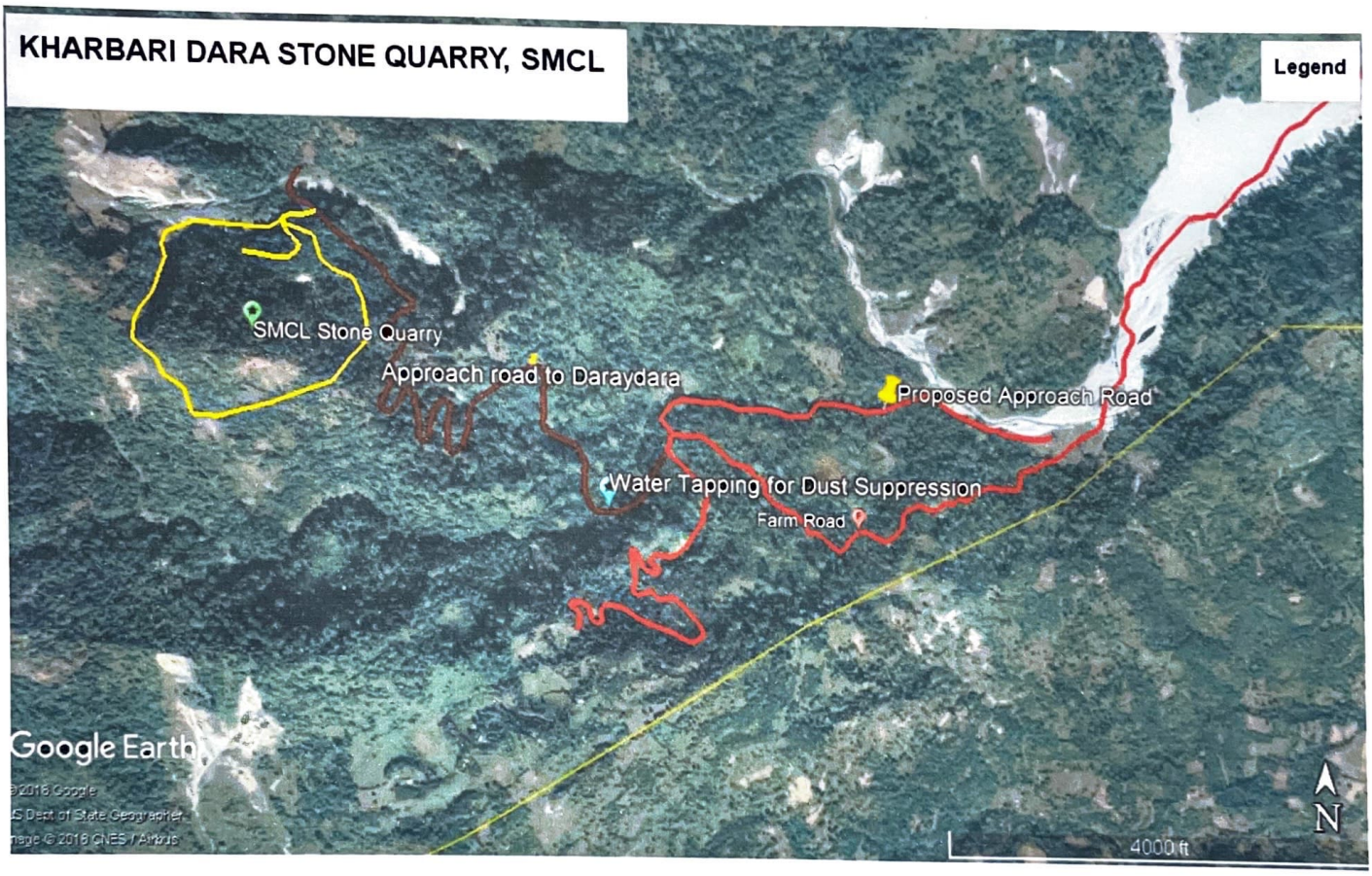
1. Location Map
2. Google Photo
3. Topo-Geo & Demarcation Map
4. Pit Plans
5. Sections

Annex 1. Location Map:

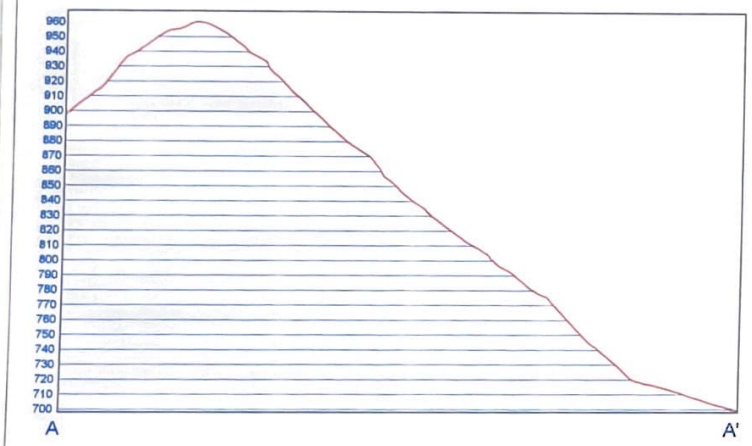
Toposheet No. 78F/5

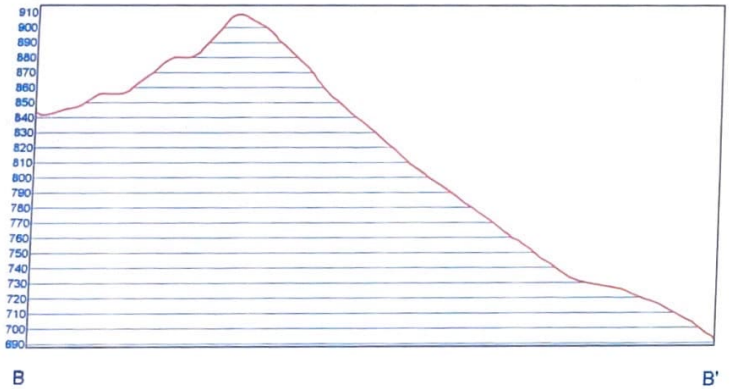


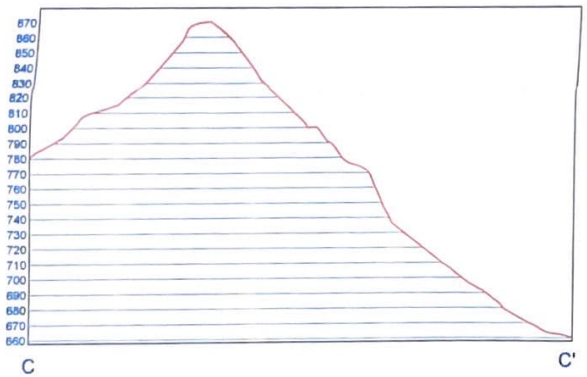
Annex 2. Google Photo:

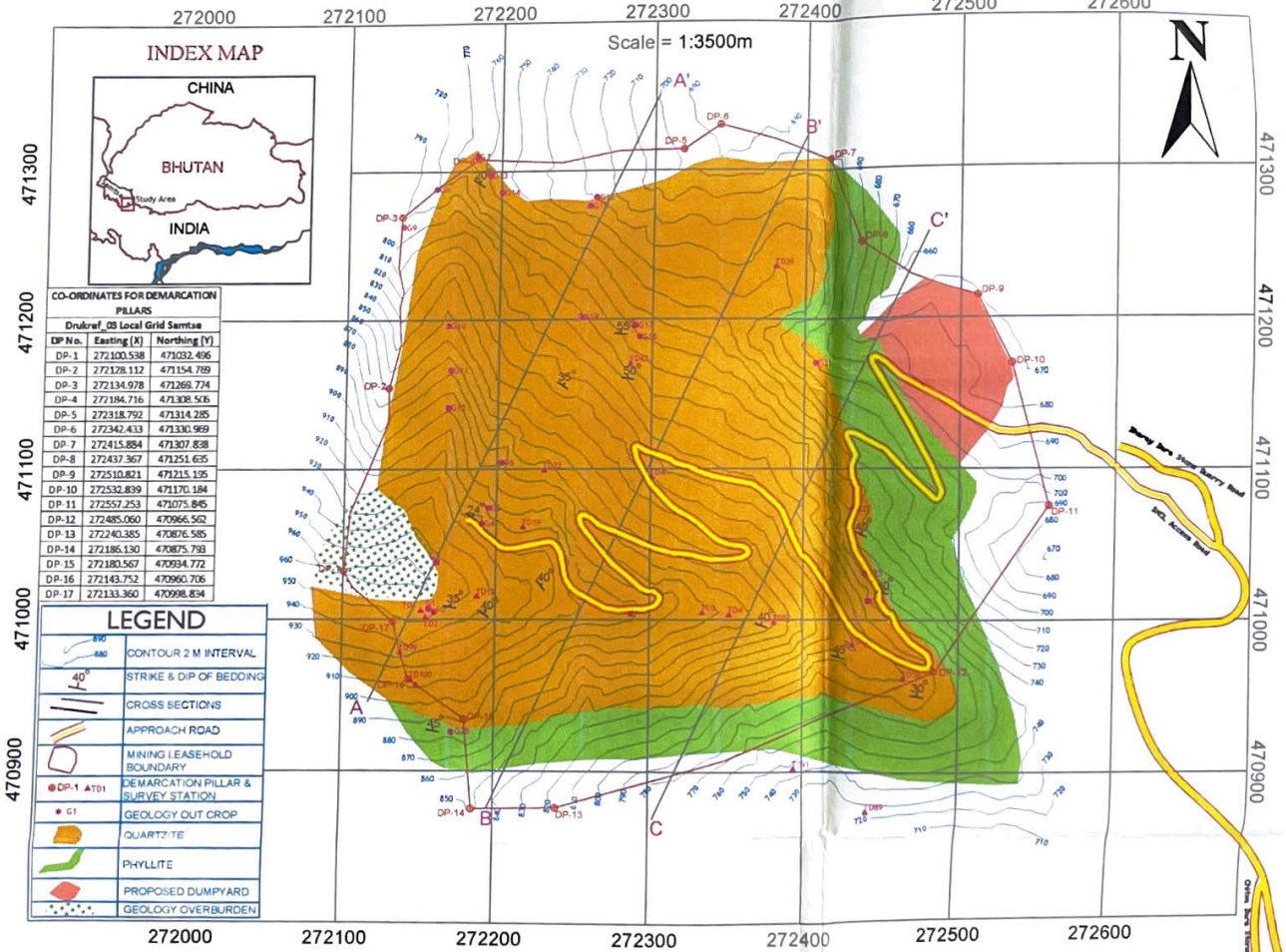


TOPOGRAPHICAL & GEOLOGICAL MAP OF KHARBARIDARA STONE QUARRY







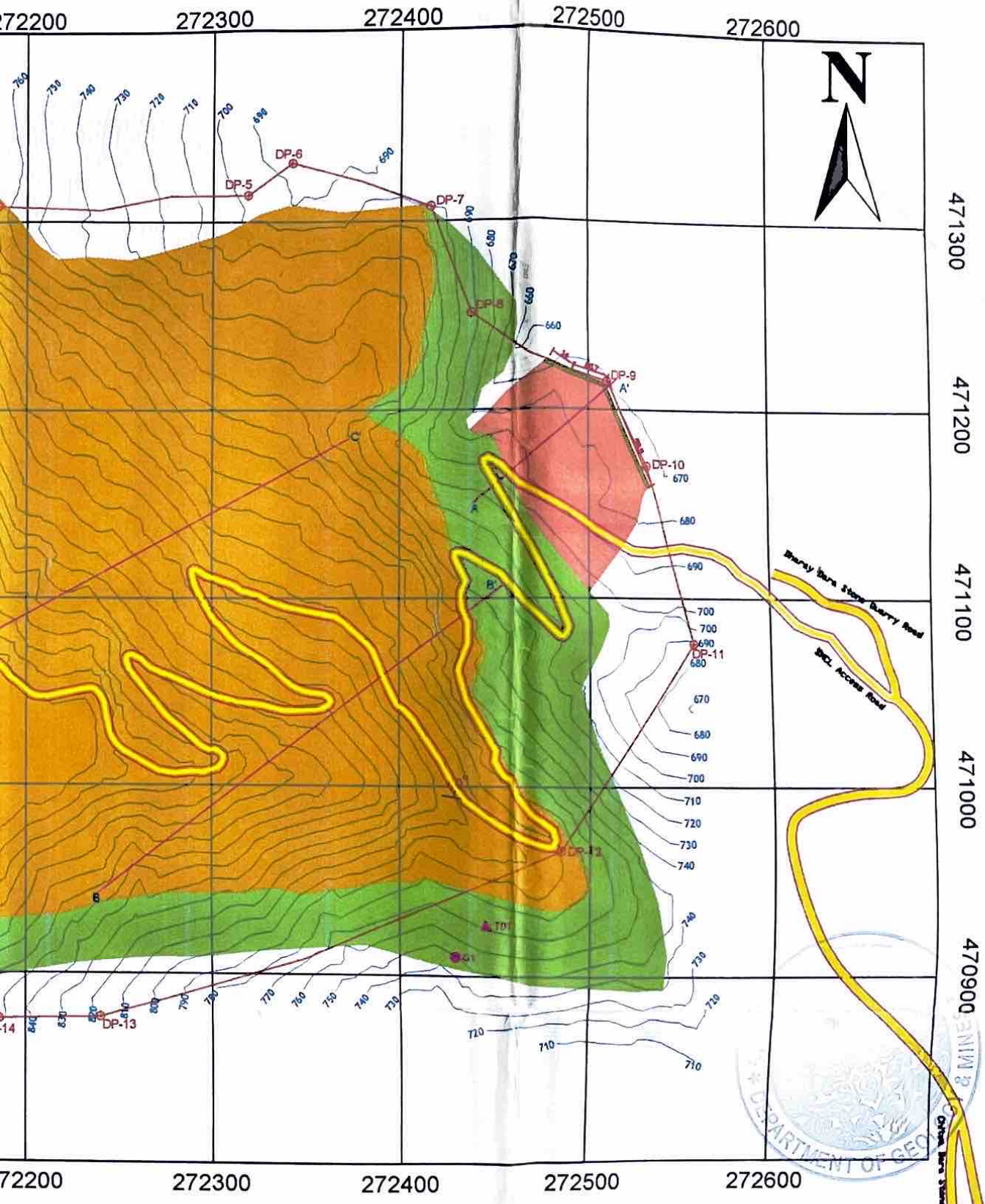


CO-ORDINATES FOR DEMARCATION PILLARS

Drukref_08 Local Grid Samtse		
DP No.	Easting (X)	Northing (Y)
DP-1	272100.538	471032.496
DP-2	272128.112	471154.789
DP-3	272134.978	471269.774
DP-4	272184.716	471308.506
DP-5	272318.792	471314.285
DP-6	272342.433	471330.969
DP-7	272415.884	471307.838
DP-8	272437.367	471251.635
DP-9	272510.821	471215.105
DP-10	272532.839	471170.184
DP-11	272557.253	471075.845
DP-12	272485.060	470966.562
DP-13	272240.385	470876.585
DP-14	272186.130	470875.793
DP-15	272180.567	470934.772
DP-16	272143.752	470960.706
DP-17	272133.360	470998.834

Project Title:	Date	Location	Kharbari Dara	Promoter	State Mining Corporation Limited Samtse	Surveyed & Mapping By:	1 - Namgay Dorji (Syr, PMD, SMCL) 2 - Ugyen Tempa (Syr Ass, PMD, SMCL)	Demarcated By:	Phuntsho Namgay, DGM	Geology Mapping By:	1 - K.B Tamang (Spe.Geologist, PMD, SMCL) 2 - Karma Dendup (Geologist, PMD, SMCL)	Verified & Approved By:	Area : 36.764 Acre/14.87 Hectares
Detail Geological Mapping & Topographical Survey of Kharbari Dara Stone Quarry (Samtse, Tading)	10-10-2018	Gewog	Tading										
		Dzongkhag	Samtse										
		Dumkhar											

1st YEAR


272200
272300
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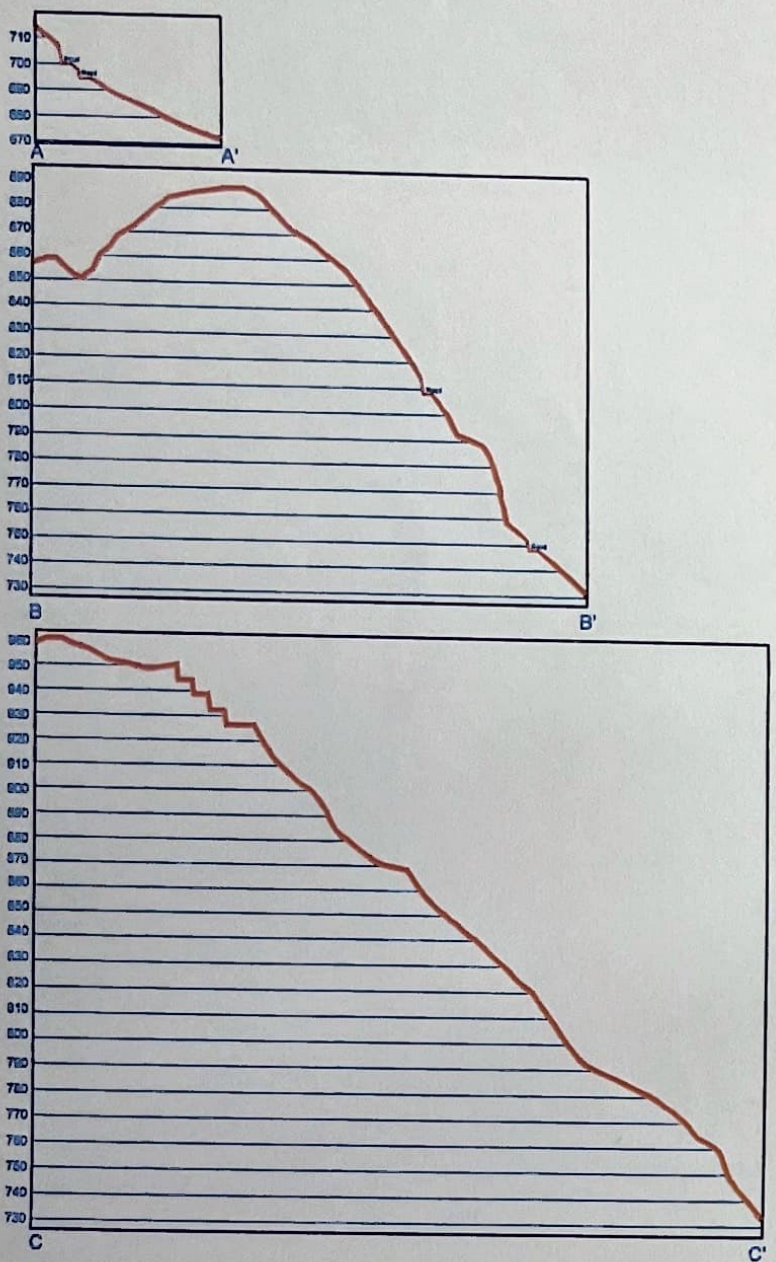
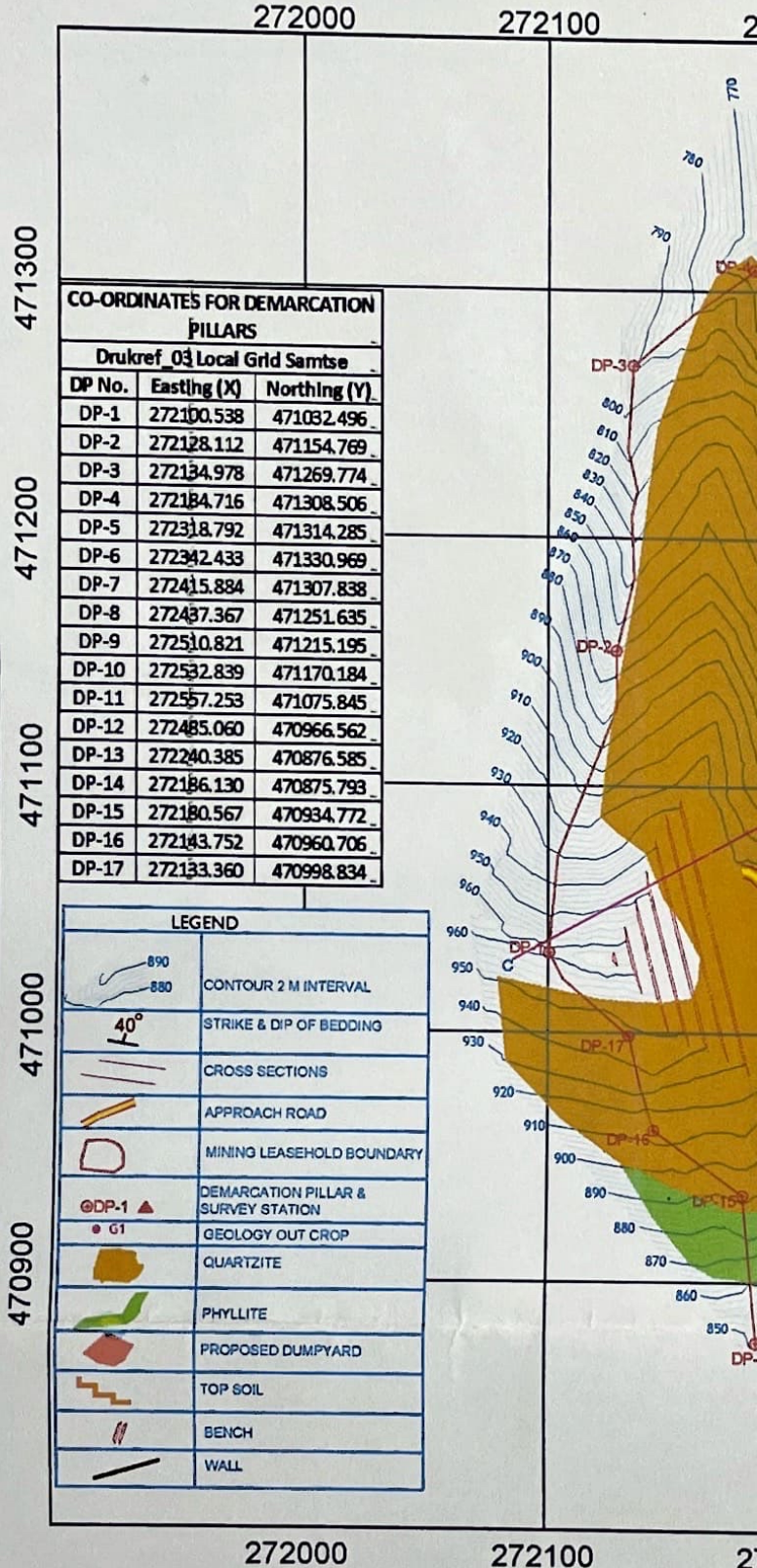
N
471300
471200
471100
471000
470900
DP-5
DP-6
DP-7
DP-8
DP-9
DP-10
DP-11
DP-12
DP-13
DP-14
A
A'
B
B'
C
C'
Sherry Yard Stone Quarry Road
SRCL Access Road
Sherry Yard Stone Quarry Road





CO-ORDINATES FOR DEMARCATION PILLARS		
Drukref_03 Local Grid Samtse		
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DP-1	272100.538	471032.496
DP-2	272128.112	471154.769
DP-3	272134.978	471269.774
DP-4	272184.716	471308.506
DP-5	272318.792	471314.285
DP-6	272342.433	471330.969
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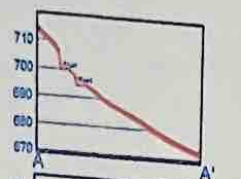
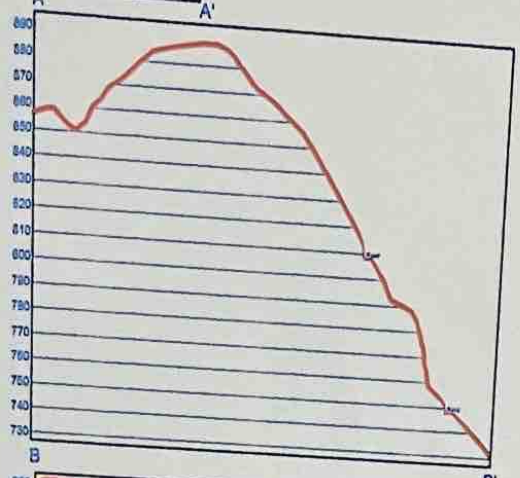
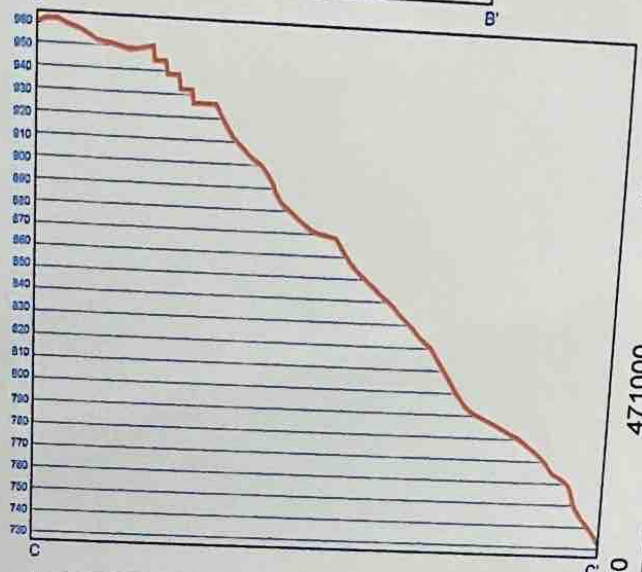
DP-11	272557.253	471075.845
DP-12	272485.060	470966.562
DP-13	272240.385	470876.585
DP-14	272186.130	470875.793
DP-15	272180.567	470934.772
DP-16	272143.752	470960.706
DP-17	272133.360	470998.834

LEGEND	
890 / 880	CONTOUR 2 M INTERVAL
40°	STRIKE & DIP OF BEDDING
	CROSS SECTIONS
	APPROACH ROAD
	MINING LEASEHOLD BOUNDARY
DP-1	DEMARCATION PILLAR & SURVEY STATION
G1	GEOLOGY OUT CROP
	QUARTZITE
	PHYLLITE
	PROPOSED DUMPYARD
	TOP SOIL
	BENCH
	WALL

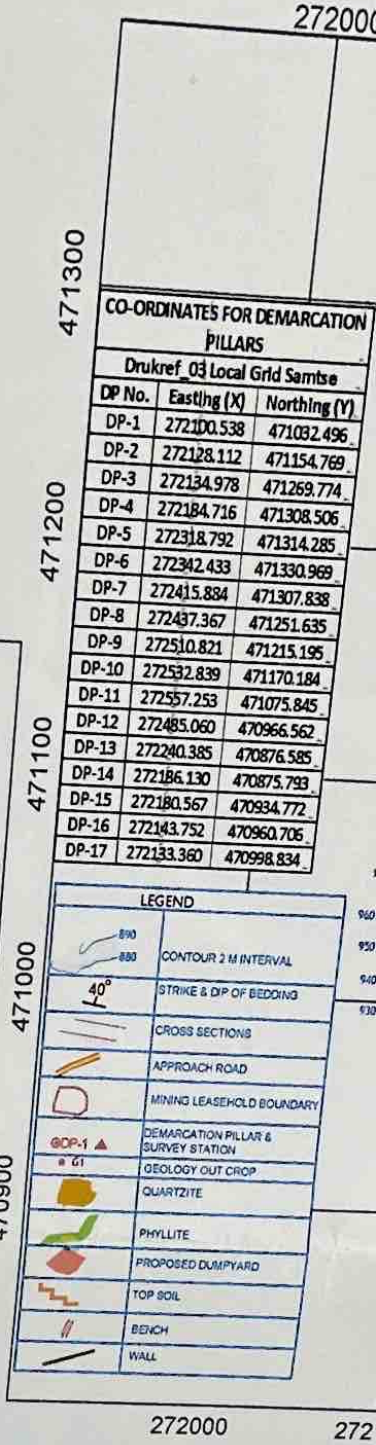
DRAWING NAME	LAYOUT PLAN
DRAWING DATE	25-Dec-17
DRAWING SCALE	1:3000m
LEASE AREA	36.764Acre/14.87H
PROMOTER	SMCL
SURVEYED BY	Namgay Dorji, SMCL
GEOLOGY BY:	K.B Tamang & Karma Dendup,SMCL
PIT PLAN DESIGNED BY:	Sangay Tshering & Phub Dorji, SMCL
CONTOUR INTERVAL	2m







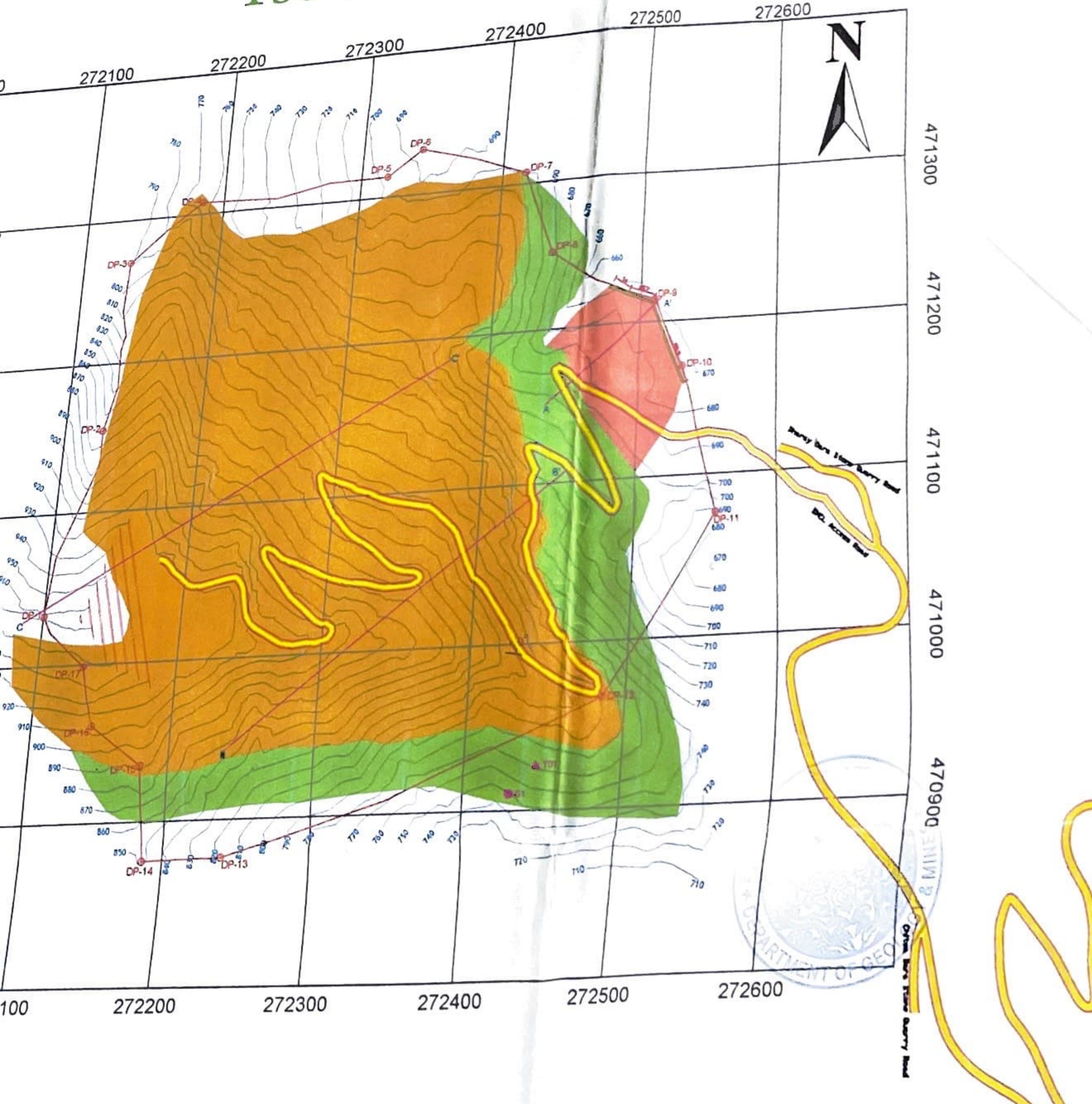
DRAWING NAME	LAYOUT PLAN
DRAWING DATE	25-Dec-17
DRAWING SCALE	1:3000m
LEASE AREA	36.764Acre/14.87H
PROMOTER	SMCL
SURVEYED BY	Namgay Dorji, SMCL
GEOLOGY BY:	K.B Tamang & Karma Dendup,SMCL
PIT PLAN DESIGNED BY:	Sangay Tshering & Phub Dorji, SMCL
CONTOUR INTERVAL	2m



CO-ORDINATES FOR DEMARCATION PILLARS		
Drukref_03 Local Grid Samtse		
DP No.	Easting (X)	Northing (Y)
DP-1	272100.538	471032.496
DP-2	272128.112	471154.769
DP-3	272134.978	471269.774
DP-4	272184.716	471308.506
DP-5	272318.792	471314.285
DP-6	272342.433	471330.969
DP-7	272415.884	471307.838
DP-8	272437.367	471251.635
DP-9	272510.821	471215.195
DP-10	272532.839	471170.184
DP-11	272557.253	471075.845
DP-12	272485.060	470966.562
DP-13	272240.385	470876.585
DP-14	272186.130	470875.793
DP-15	272180.567	470934.772
DP-16	272143.752	470960.706
DP-17	272133.360	470998.834

LEGEND	
890 / 880	CONTOUR 2 M INTERVAL
40°	STRIKE & DIP OF BEDDING
	CROSS SECTIONS
	APPROACH ROAD
	MINING LEASEHOLD BOUNDARY
DP-1	DEMARCATION PILLAR & SURVEY STATION
GI	GEOLOGY OUT CROP
	QUARTZITE
	PHYLLITE
	PROPOSED DUMPYARD
	TOP SOIL
	BENCH
	WALL

1st YEAR



N
272100
272200
272300
272400
272500
272600
471300
471200
471100
471000
470900
DP-2
DP-3
DP-5
DP-6
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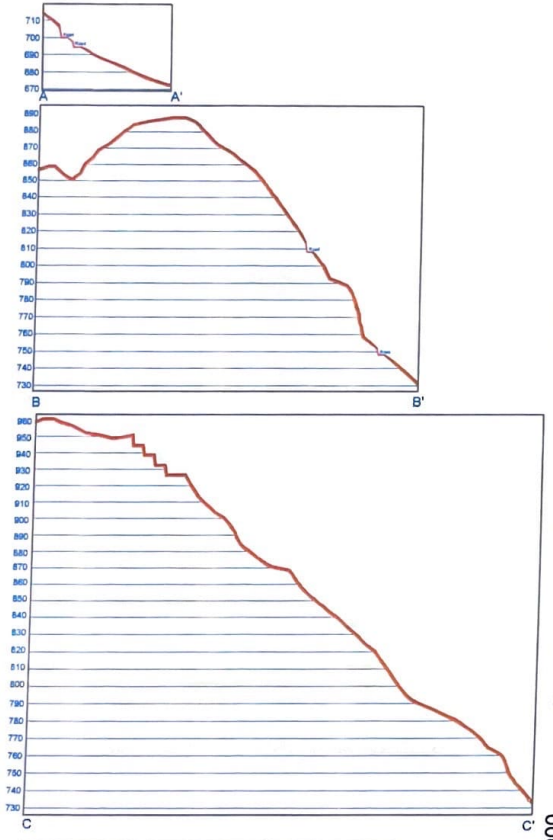
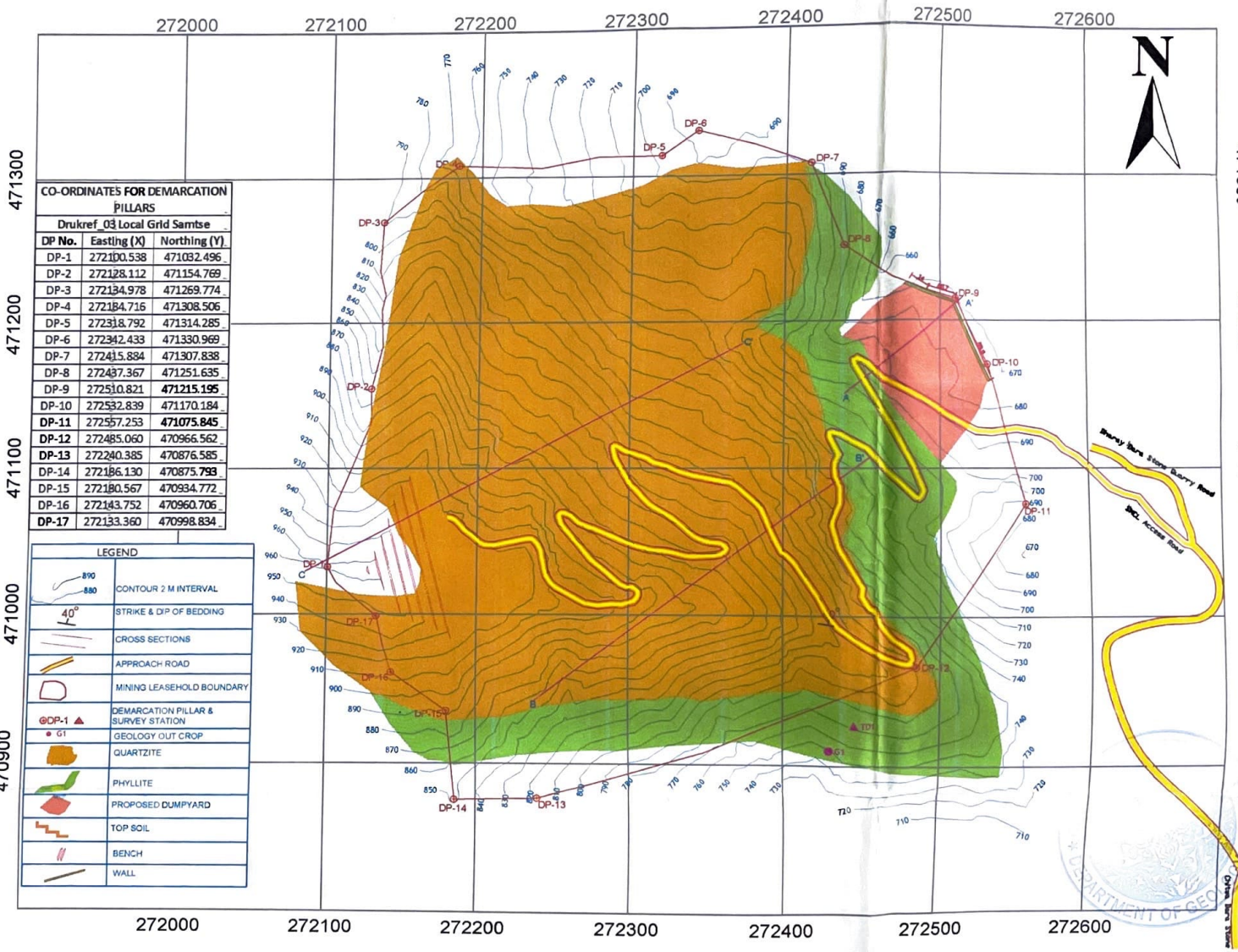
DP-8
DP-9
DP-10
DP-11
DP-12
DP-13
DP-14
DP-15
DP-16
DP-17
A
A'
B
B'
C

1st YEAR



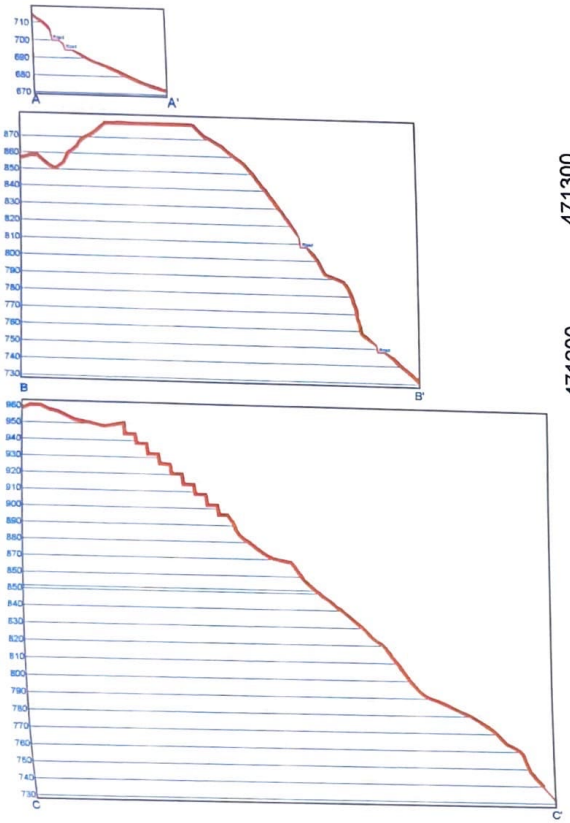
CO-ORDINATES FOR DEMARCATION PILLARS		
Drukref_03 Local Grid Samtse		
DP No.	Easting (X)	Northing (Y)
DP-1	272100.538	471032.496
DP-2	272128.112	471154.769
DP-3	272134.978	471269.774
DP-4	272184.716	471308.506
DP-5	272318.792	471314.285
DP-6	272342.433	471330.969
DP-7	272415.884	471307.838
DP-8	272437.367	471251.635
DP-9	272510.821	**471215.195**
DP-10	272532.839	471170.184
DP-11	272557.253	**471075.845**
DP-12	272485.060	470966.562
DP-13	272240.385	470876.585
DP-14	272186.130	470875.793
DP-15	272180.567	470934.772
DP-16	272143.752	470960.706
DP-17	272133.360	470998.834



LEGEND	
890 / 880	CONTOUR 2 M INTERVAL
40°	STRIKE & DIP OF BEDDING
	CROSS SECTIONS
	APPROACH ROAD
	MINING LEASEHOLD BOUNDARY
DP-1	DEMARCATION PILLAR & SURVEY STATION
G1	GEOLOGY OUT CROP
	QUARTZITE
	PHYLLITE
	PROPOSED DUMPYARD
	TOP SOIL
	BENCH
	WALL

DRAWING NAME	LAYOUT PLAN
DRAWING DATE	25-Dec-17
DRAWING SCALE	1:3000m
LEASE AREA	36.764Acre/14.87H
PROMOTER	SMCL
SURVEYED BY	Namgay Dorji, SMCL
GEOLOGY BY:	K.B Tamang & Karma Dendup,SMCL
PIT PLAN DESIGNED BY:	Sangay Tshering & Phub Dorji, SMCL
CONTOUR INTERVAL	2m

2nd YEAR



CO-ORDINATES FOR DEMARCATION PILLARS		
Drukref_03 Local Grid Samtse		
DP No.	Easting (X)	Northing (Y)
DP-1	272100.538	471032.496
DP-2	272128.112	471154.769
DP-3	272134.978	471269.774
DP-4	272184.716	471308.506
DP-5	272318.792	471314.285
DP-6	272342.433	471330.969
DP-7	272415.884	471307.838
DP-8	272437.367	471251.635
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DP-10	272532.839	471170.184
DP-11	272557.253	471075.845
DP-12	272485.060	470966.562
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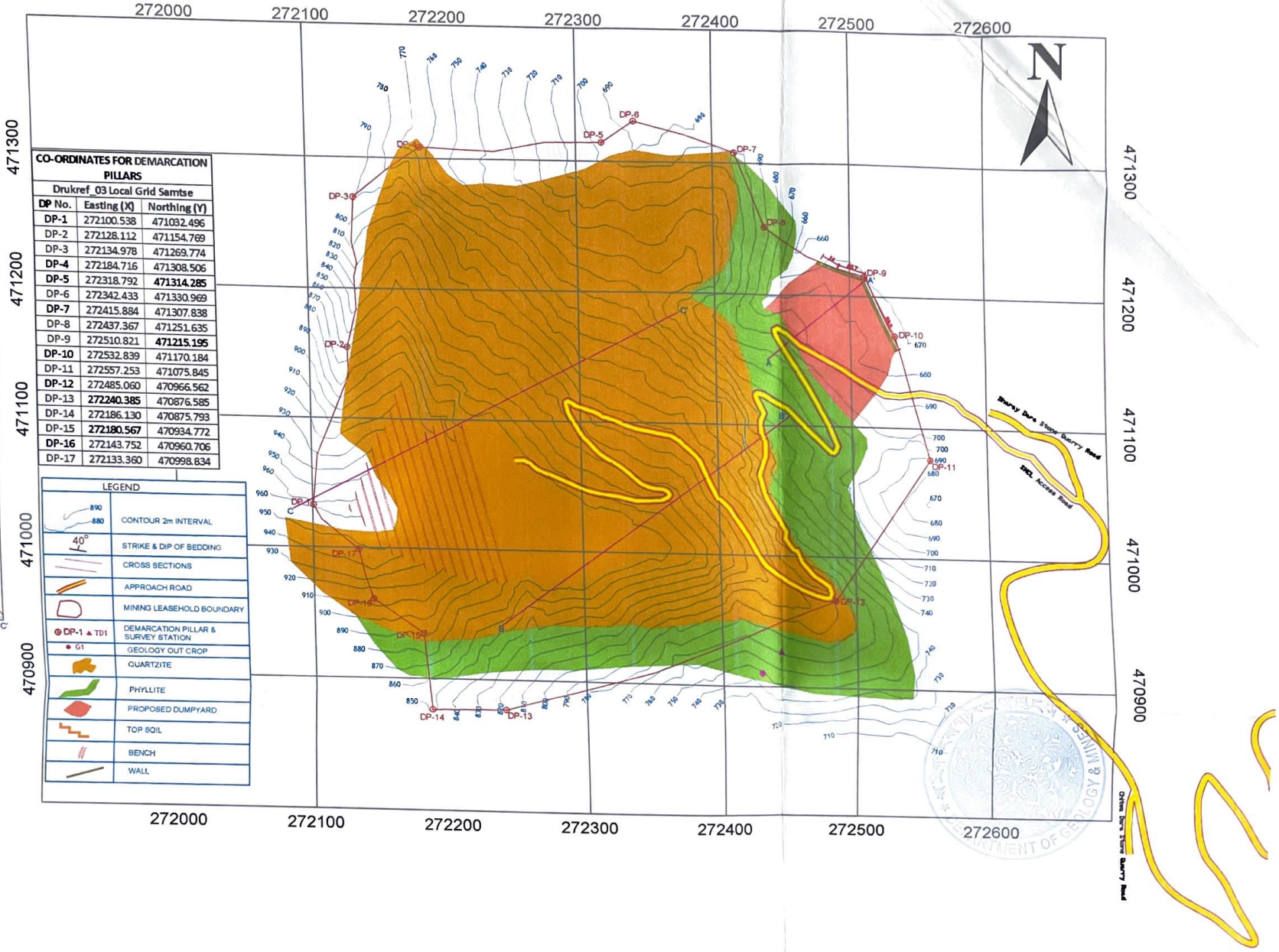
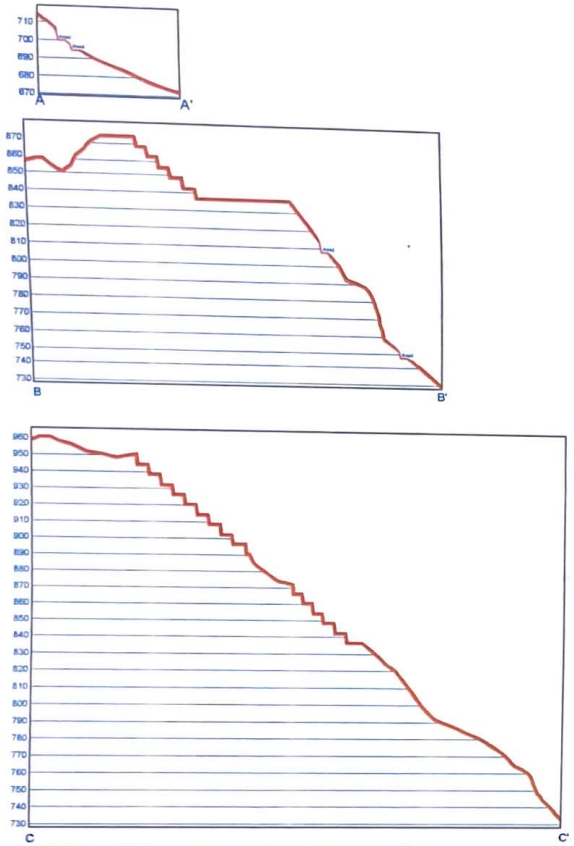
DP-15	272180.567	470934.772
DP-16	272143.752	470960.706
DP-17	272133.360	470998.834

LEGEND	
890 880	CONTOUR 2m INTERVAL
40°	STRIKE & DIP OF BEDDING
	CROSS SECTIONS
	APPROACH ROAD
	MINING LEASEHOLD BOUNDARY
DP-1 ▲ TD1	DEMARCATION PILLAR & SURVEY STATION
G1	GEOLOGY OUT CROP
	QUARTZITE
	PHYLLITE
	PROPOSED DUMPYARD
	TOP SOIL
	BENCH
	WALL



DRAWING NAME	LAYOUT PLAN
DRAWING DATE	25-Dec-17
DRAWING SCALE	1:3000m
LEASE AREA	36.764Acre/14.87H
PROMOTER	SMCL
SURVEYED BY	Namgay Dorji, SMCL
GEOLOGY BY:	K.B Tamang & Karma Dendup,SMCL
PIT PLAN DESIGNED BY:	Sangay Tshering & Phub Dorji, SMCL
CONTOUR INTERVAL	2m

3rd YEAR



CO-ORDINATES FOR DEMARCATION PILLARS		
Drukref_03 Local Grid Samtse		
DP No.	Easting (X)	Northing (Y)
DP-1	272100.538	471032.496
DP-2	272128.112	471154.769
DP-3	272134.978	471269.774
DP-4	272184.716	471308.506
DP-5	272318.792	471314.285
DP-6	272342.433	471330.969
DP-7	272415.884	471307.838
DP-8	272437.367	471251.635
DP-9	272510.821	471215.195
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DP-11	272557.253	471075.845
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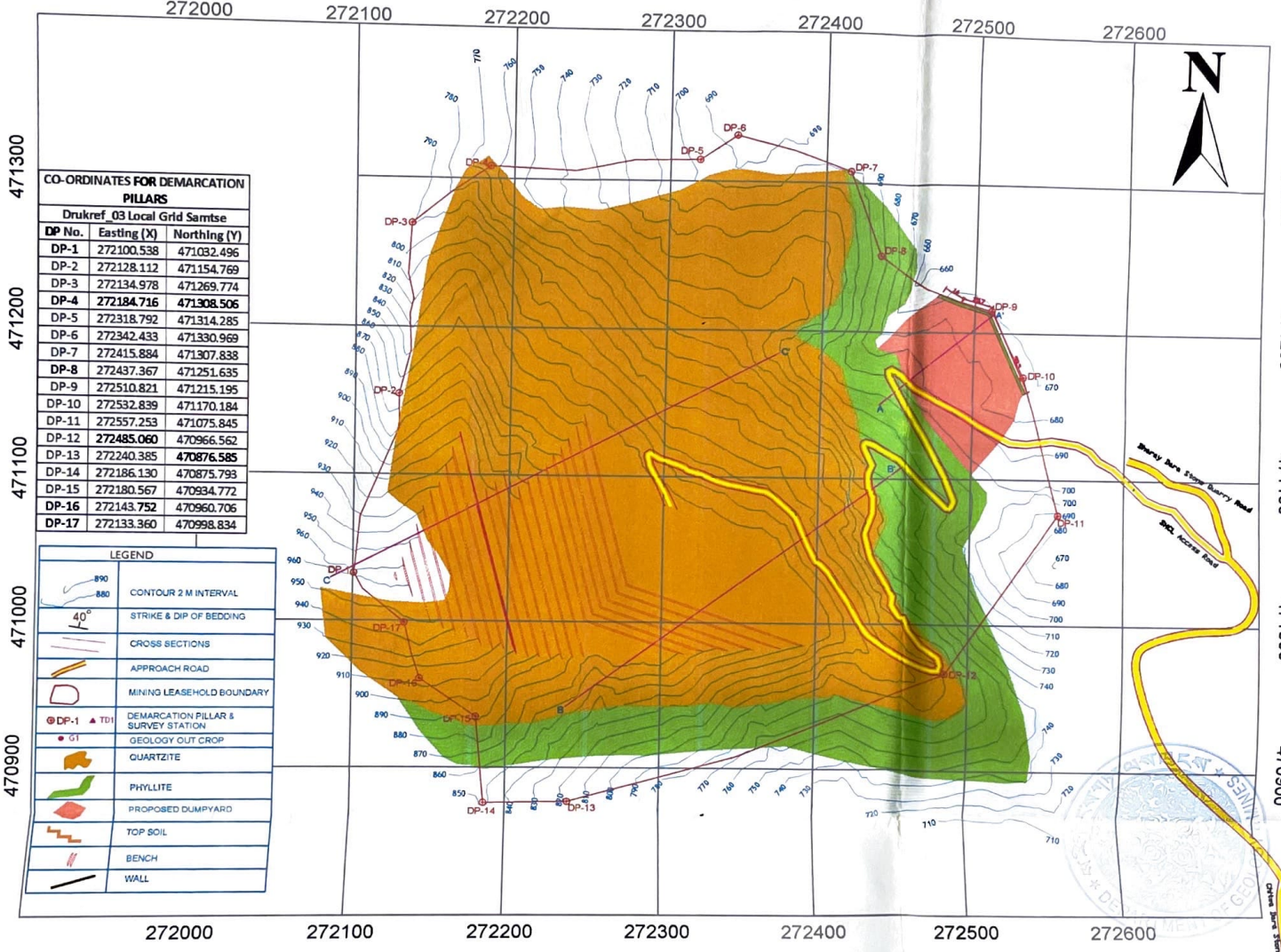
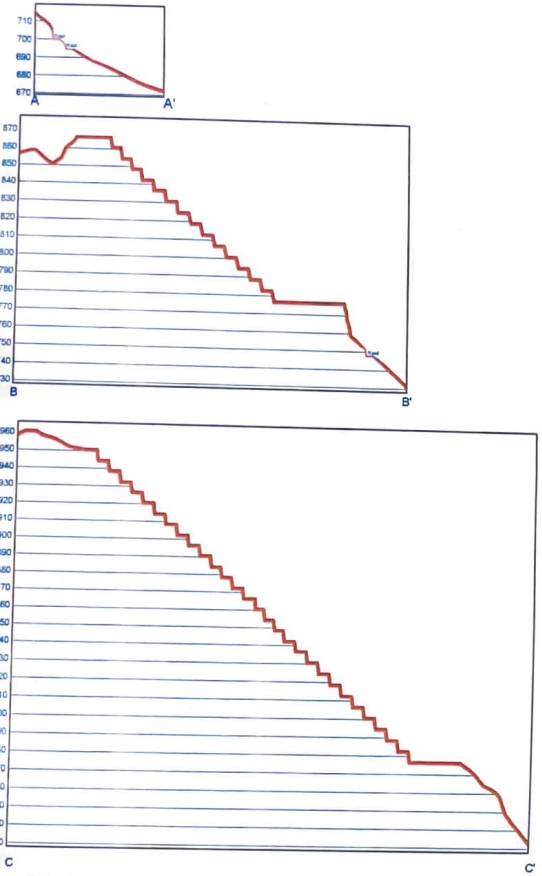
DP-15	272180.567	470934.772
DP-16	272143.752	470960.706
DP-17	272133.360	470998.834



LEGEND	
890 / 880	CONTOUR 2 M INTERVAL
40°	STRIKE & DIP OF BEDDING
	CROSS SECTIONS
	APPROACH ROAD
	MINING LEASEHOLD BOUNDARY
DP-1 ▲ TD1	DEMARCATION PILLAR & SURVEY STATION
G1	GEOLOGY OUT CROP
	QUARTZITE
	PHYLLITE
	PROPOSED DUMPYARD
	TOP SOIL
	BENCH
	WALL

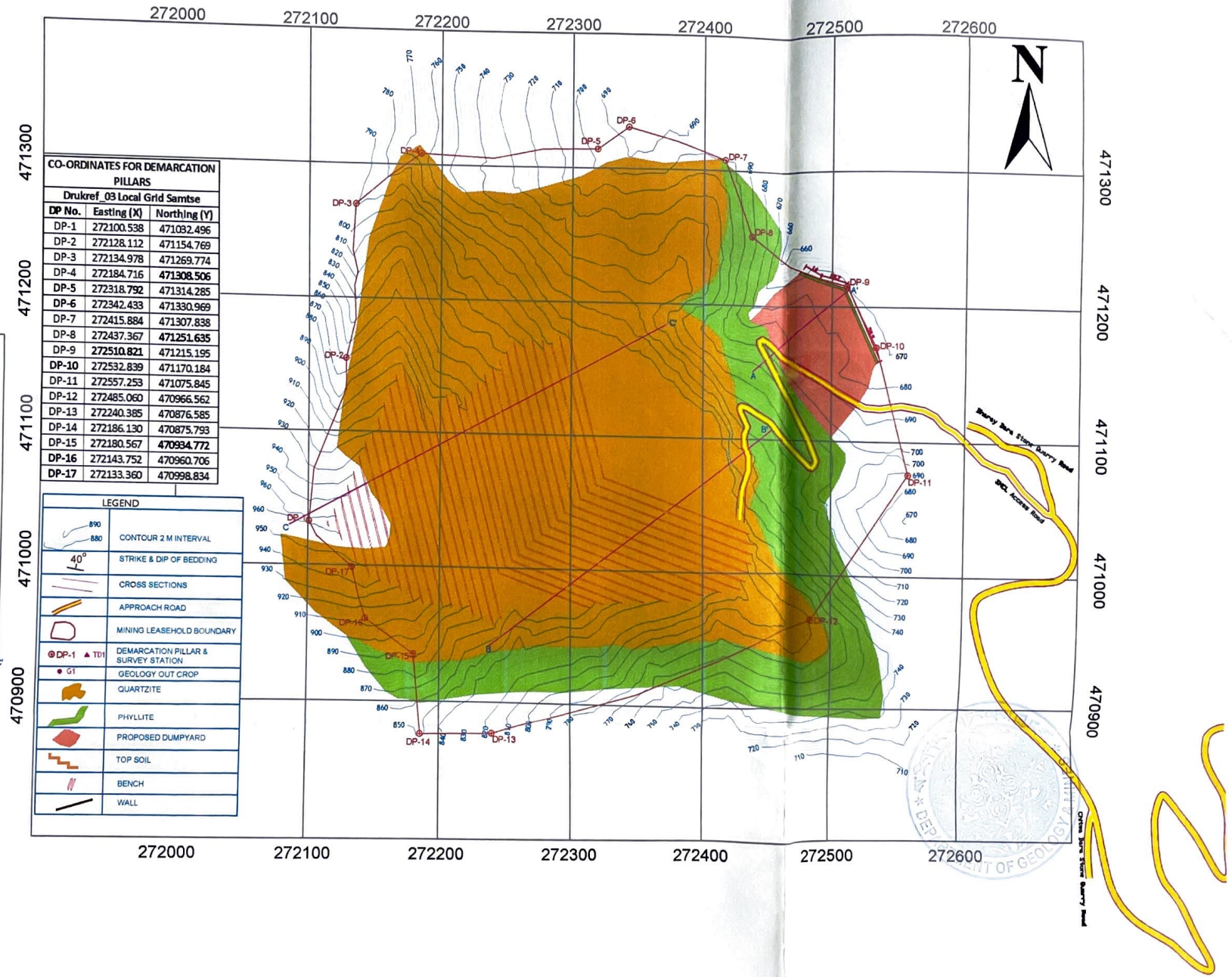
DRAWING NAME	LAYOUT PLAN
DRAWING DATE	25-Dec-17
DRAWING SCALE	1:3000m
LEASE AREA	36.764Acre/14.87H
PROMOTER	SMCL
SURVEYED BY	Namgay Dorji, SMCL
GEOLOGY BY:	K.B Tamang & Karma Dendup,SMCL
PIT PLAN DESIGNED BY:	Sangay Tshering & Phub Dorji, SMCL
CONTOUR INTERVAL	2m

4th YEAR

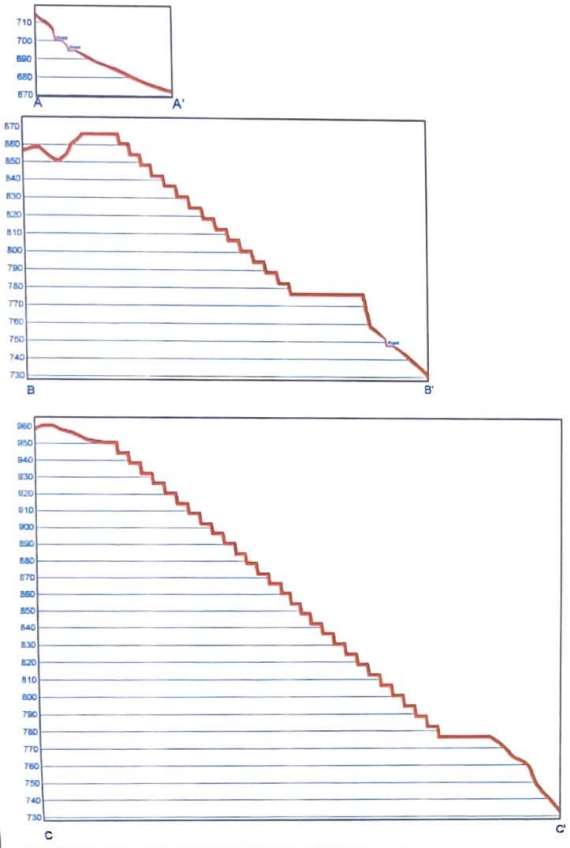


DRAWING NAME	LAYOUT PLAN
DRAWING DATE	25-Dec-17
DRAWING SCALE	1:3000
LEASE AREA	36.764Acre/14.87H
PROMOTER	SMCL
SURVEYED BY	Namgay Dorji, SMCL
GEOLOGY BY:	K.B Tamang & Karma Dendup,SMCL
PIT PLAN DESIGNED BY:	Sangay Tshering & Phub Dorji, SMCL
CONTOUR INTERVAL	2m

CO-ORDINATES FOR DEMARCATION PILLARS		
Drukref_03 Local Grid Samtse		
DP No.	Easting (X)	Northing (Y)
DP-1	272100.538	471082.496
DP-2	272128.112	471154.769
DP-3	272134.978	471269.774
DP-4	272184.716	471308.506
DP-5	272318.792	471314.285
DP-6	272342.433	471330.969
DP-7	272415.884	471307.838
DP-8	272437.367	471251.635
DP-9	272510.821	471215.195
DP-10	272532.839	471170.184
DP-11	272557.253	471075.845
DP-12	272485.060	470966.562
DP-13	272240.385	470876.585
DP-14	272186.130	470875.793
DP-15	272180.567	470934.772
DP-16	272143.752	470960.706
DP-17	272133.360	470998.834



5th YEAR



DRAWING NAME	LAYOUT PLAN
DRAWING DATE	25-Dec-17
DRAWING SCALE	1:3000
LEASE AREA	36.764Acre/14.87H
PROMOTER	SMCL
SURVEYED BY	Namgay Dorji, SMCL
GEOLOGY BY:	K.B Tamang & Karma Dendup,SMCL
PIT PLAN DESIGNED BY:	Sangay Tshering & Phub Dorji, SMCL
CONTOUR INTERVAL	2m

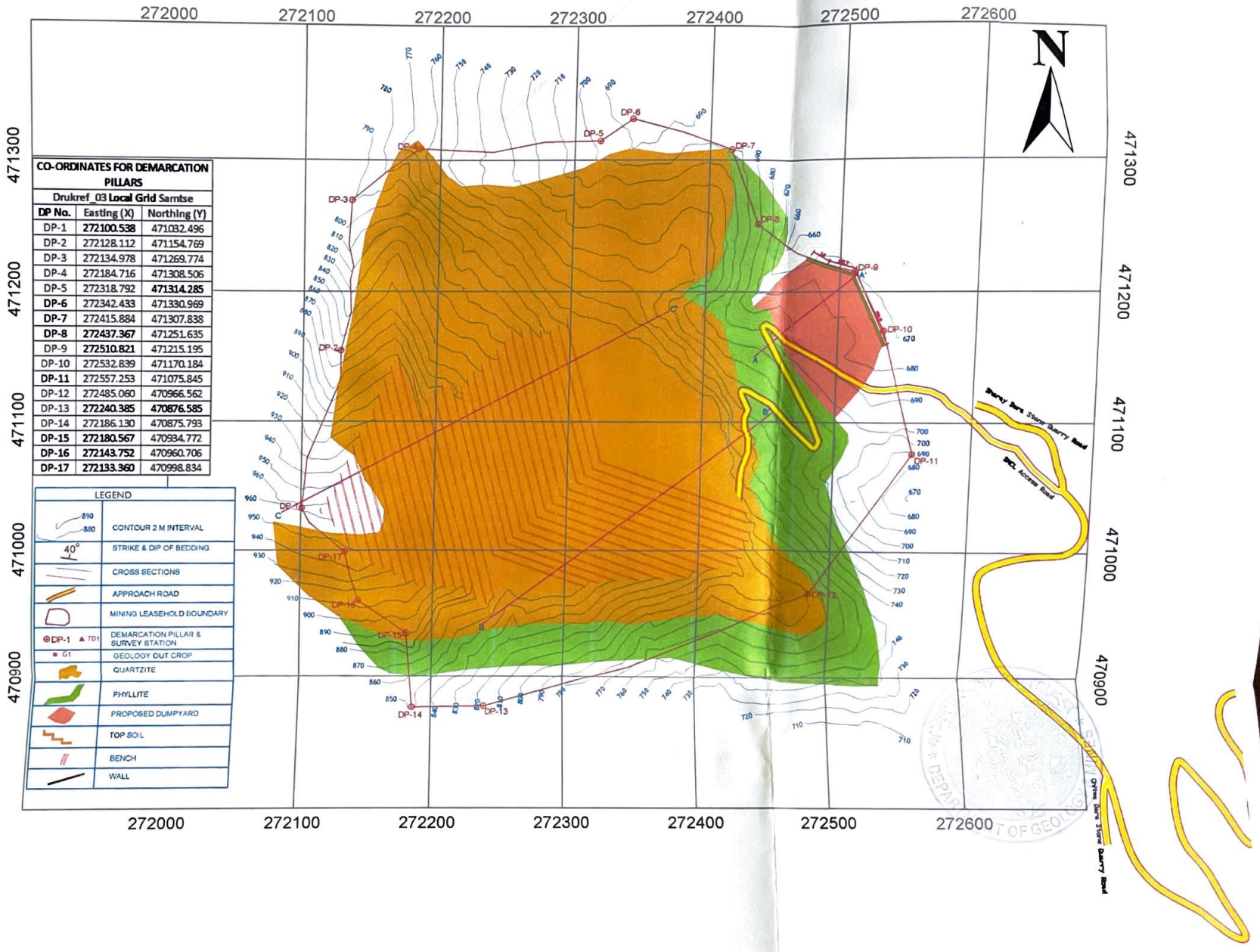
CO-ORDINATES FOR DEMARCATION PILLARS

Drukref_03 Local Grid Samtse

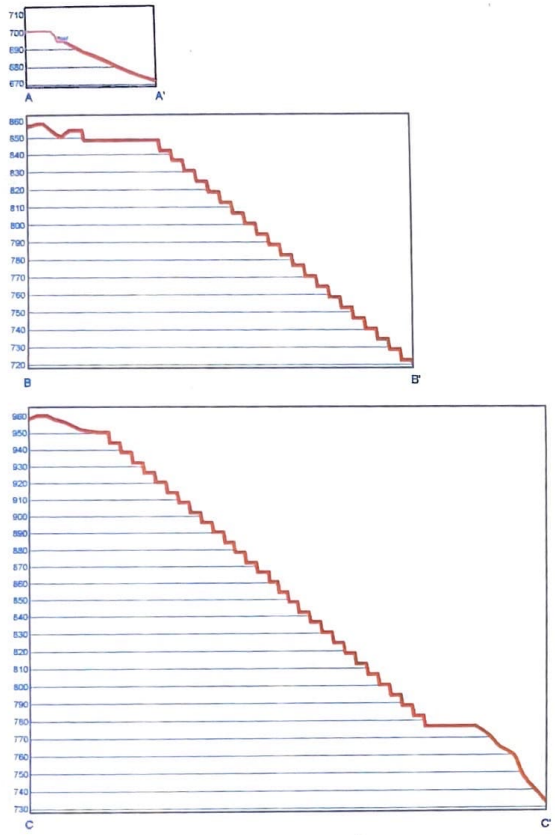
DP No.	Easting (X)	Northing (Y)
DP-1	272100.538	471032.496
DP-2	272128.112	471154.769
DP-3	272134.978	471269.774
DP-4	272184.716	471308.506
DP-5	272318.792	471314.285
DP-6	272342.433	471330.969
DP-7	272415.884	471307.838
DP-8	272437.367	471251.635
DP-9	272510.821	471215.195
DP-10	272532.839	471170.184
DP-11	272557.253	471075.845
DP-12	272485.060	470966.562
DP-13	272240.385	470876.585
DP-14	272186.130	470875.793
DP-15	272180.567	470934.772
DP-16	272143.752	470960.706
DP-17	272133.360	470998.834

LEGEND

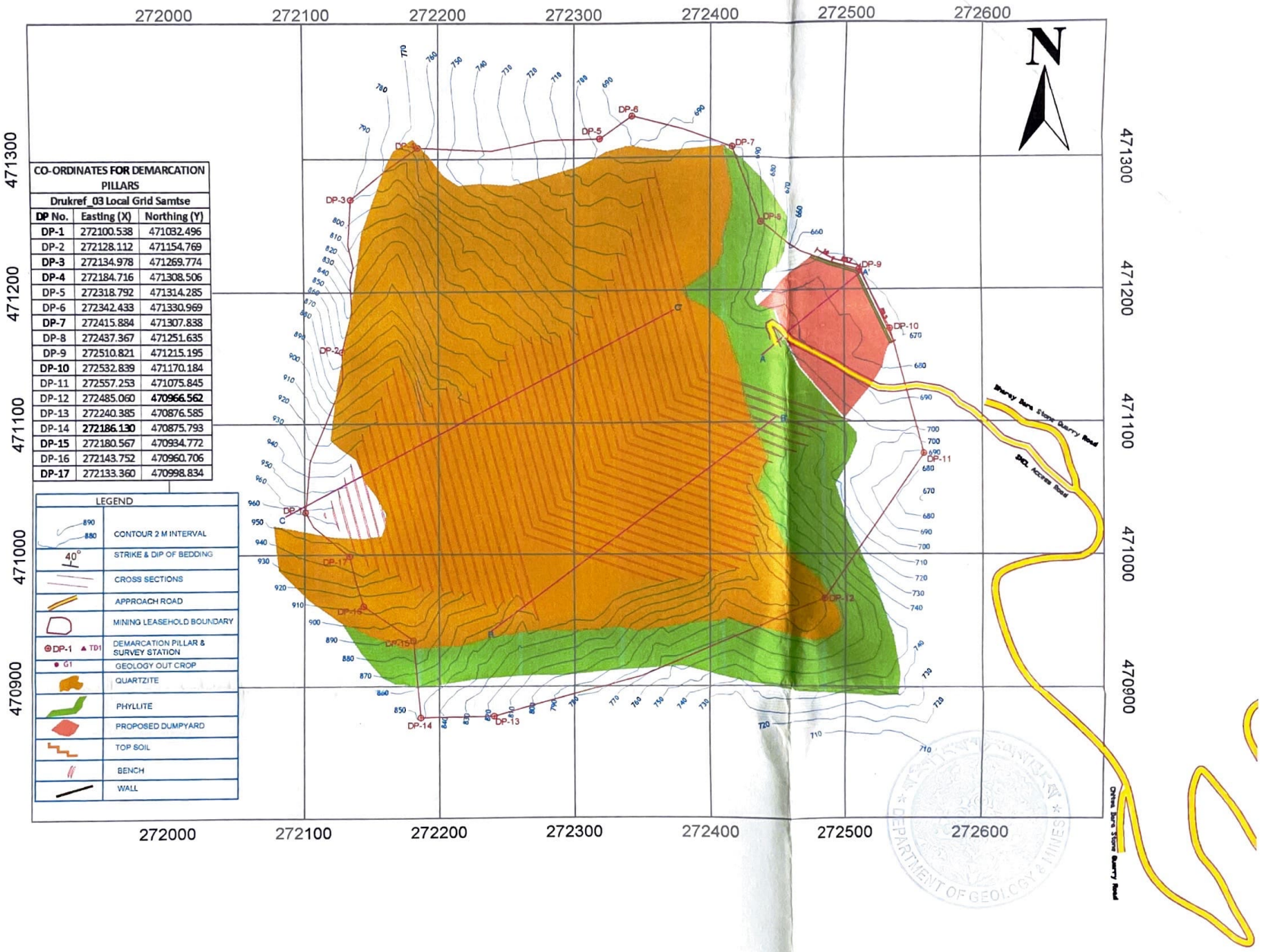
- CONTOUR 2 M INTERVAL
- STRIKE & DIP OF BEDDING
- CROSS SECTIONS
- APPROACH ROAD
- MINING LEASEHOLD BOUNDARY
- DP-1 ▲ TD1 — DEMARCATION PILLAR & SURVEY STATION
- G1 — GEOLOGY OUT CROP
- QUARTZITE
- PHYLLITE
- PROPOSED DUMPYARD
- TOP SOIL
- BENCH
- WALL



6th to 10th YEAR



DRAWING NAME	LAYOUT PLAN
DRAWING DATE	25-Dec-17
DRAWING SCALE	1:3000m
LEASE AREA	36.764Acre/14.87H
PROMOTER	SMCL
SURVEYED BY	Namgay Dorji, SMCL
GEOLOGY BY:	K.B Tamang & Karma Dendup,SMCL
PIT PLAN DESIGNED BY:	Sangay Tshering & Phub Dorji, SMCL
CONTOUR INTERVAL	2m



CO-ORDINATES FOR DEMARCATION PILLARS		
Drukref_03 Local Grid Samtse		
DP No.	Easting (X)	Northing (Y)
DP-1	272100.538	471032.496
DP-2	272128.112	471154.769
DP-3	272134.978	471269.774
DP-4	272184.716	471308.506
DP-5	272318.792	471314.285
DP-6	272342.433	471330.969
DP-7	272415.884	471307.838
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DP-10	272532.839	471170.184
DP-11	272557.253	471075.845
DP-12	272485.060	470966.562
DP-13	272240.385	470876.585
DP-14	272186.130	470875.793
DP-15	272180.567	470934.772
DP-16	272143.752	470960.706
DP-17	272133.360	470998.834

LEGEND	
890 / 880	CONTOUR 2 M INTERVAL
40°	STRIKE & DIP OF BEDDING
	CROSS SECTIONS
	APPROACH ROAD
	MINING LEASEHOLD BOUNDARY
DP-1 ▲ TD1	DEMARCATION PILLAR & SURVEY STATION
G1	GEOLOGY OUT CROP
	QUARTZITE
	PHYLLITE
	PROPOSED DUMPYARD
	TOP SOIL
	BENCH
	WALL