

FINAL MINE FEASIBILITY STUDY
REPORT PART I
MINE PLAN & FEASIBILITY

MIS

for
NGANGSING STONE QUARRY, TSHELINGOR
Zobel Gewog, Pemagatshel

FINAL REPORT

JUNE 2012

Prepared for



NRDCL

NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED
THIMPHU BHUTAN

By

MANI KUMAR PRADHAN, MINING SPECIALIST





དཔལ་ལྷན་འབྲེལ་གཞི་རྒྱུ་ བསྟན་འཛིན་ལྷན་ཁག།
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 DEPARTMENT OF GEOLOGY AND MINES
 MINISTRY OF ECONOMIC AFFAIRS
 ROYAL GOVERNMENT OF BHUTAN
 THIMPHU

X-77/DGM/2012/ 345-

October 4, 2012

APPROVAL of FMFS Report and EMP

The Mines Evaluation Section of the Mining Division has evaluated the Final Mine Feasibility Study (FMFS) report and the Environmental Management Plan (EMP) of the proposed **Ngangsing Stone Quarry**. The background and summary of the report are specified below:

Background

Date	Activity
	Applicant given permission to prepare the FMFS report and EMP for the proposed quarry for submission
January 5, 2012	Receipt of the 1 st draft FMFS report and EMP
May 10, 2012	Evaluation comments on the FMFS report and EMP forwarded to the applicant.
June 1, 2012	Receipt of the corrected final report
September 18, 2012	Receipt of environmental clearance vide letter no. NEC/ESD/DGM/2365/2012/7810

FMFS Summary

General Information

Promoter : M/s Natural Resources Development Corporation Limited (NRDCL)
 Name of the proposed quarry : Ngangsing Stone Quarry
 Location of the proposed quarry: Ngangsing (Tshelingor), Zobel Gewog, Pemagatshel Dzongkhag
 Rock type : Quartzite rock for construction purpose
 Type of operation : Semi-mechanized
 Total leased area : 12.45 hectares
 Annual Production estimates : 75000 MT
 Geological reserve estimation: 1.64 million MT
 Annual overburden generation: 5272.68m³
 Lease period applied : 10 years
 Market and Products : Aggregates and boulders for development activities like DANTAK highway double-laning and Dentsi town, Pemagatshel





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Manpower Requirement

Managerial	:	6
Technical	:	6
Support staff/operator/workers	:	23
Total	:	35

Environment Protection Measures

Method of waste disposal	:	The waste generated is proposed to dumped at predetermined waste dump site by equipment.
Environment Restoration Bond fund	:	Nu.500,000.00 per year for the first five years.

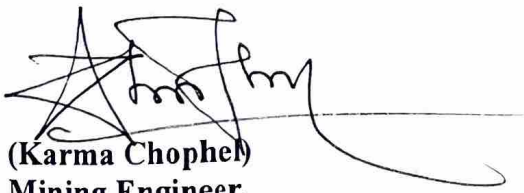
Evaluation comments:

The FMFS report and EMP has been prepared by a competent mining engineer based on approved geological report after the receipt of clearances from all the relevant agencies. They have been assessed to be acceptable for implementation based on the mineability, reserve availability, economic viability and other technical and environmental considerations as addressed in the reports. Environmental clearance has also been obtained.

Compliance requirement

- The terms and conditions laid down in all the clearances should be complied with along with terms and conditions specified in the minutes of the FMFS presentation meeting with the stakeholders.
- The quarrying operation should be carried out as per the approved FMFS report and the EMP.
- Blasting should be done after inspecting the place within and outside the quarry area which are within blasting radius for animals and humans and evacuating them.

Evaluation done by:

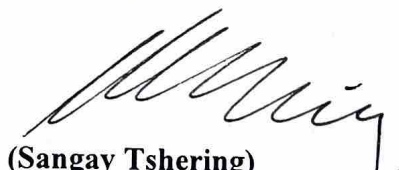

(Karma Chopel)
Mining Engineer,
Mines Evaluation Section






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DEPARTMENT OF GEOLOGY AND MINES
MINISTRY OF ECONOMIC AFFAIRS
ROYAL GOVERNMENT OF BHUTAN
THIMPHU

Verified by:


(Sangay Tshering)
Offtg. Head, Mining Division

Approved by:


Director General
Department of Geology & Mines

Copy to:

1. Offtg. Head, Mining Division, DGM, Thimphu for information
2. Head, Mines Evaluation Section, DGM, Thimphu for information
3. Head, Mines Leasing Section, DGM, Thimphu for information
- ✓ 4. Head, Mines Information Section, DGM, Thimphu for information
5. Regional Coordinator, DGM, Samdrup Jongkhar Region for information
6. Concerned Inspector, DGM, Samdrup Jongkhar Region for information
7. CEO, NRDCL, Thimphu for information.





འབྲུག་ཡུལ་མཐའ་འཁོར་གནས་སྤངས་ལྷན་ཚོགས།
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National Environment Commission
Royal Government of Bhutan



NEC/ESD/DGM/2365/2012/ 7810

September 18, 2012

ENVIRONMENTAL CLEARANCE

The National Environment Commission (NEC) is pleased to issue environmental clearance in respect of the Natural Resources Development Corporation Limited as per the decision of the Environmental Assessment Technical Committee during its meeting on 7th August, 2012 for the development of Ngangshing Stone Quarry measuring an area of 12.45 hectares and construction of 603 metres approach road to the Quarry located at Ngangshing under Zobel Gewog, Pemagatshel Dzongkhag with the following terms and conditions:

1. As per Section 28.3 of the Regulation for the Environmental Clearance of Projects 2002, any modification of proposal/application shall take place only with prior approval from NEC;
2. The holder shall ensure that the development of quarry and construction of approach road are in line with the National Environment Protection Act 2007, Environmental Assessment Act 2000 and its Regulation 2002, Waste Prevention & Management Act of Bhutan 2009 and its Regulation 2012 and The Water Act of Bhutan 2011;
3. **The holder shall ensure that this environmental clearance is valid only for the development of Ngangshing Stone Quarry and construction of approach road;**
4. The holder shall ensure that development of quarry and construction of approach road comply with the Environmental Standards 2010;
5. The holder shall ensure strict compliance to the Undertaking submitted to NEC;
6. The holder shall ensure that development of quarry and construction of approach road are carried out as per the approved Mine Plan (MP) and Environmental Management Plan (EMP) submitted for environmental clearance;
7. The holder shall ensure that development of quarry are within the allocated area;
8. The holder shall ensure that local residents, households, communities, public, private parties and any religious, cultural, historic and ecologically important sites are not adversely affected by the development of quarry and construction of approach road;
9. The holder shall ensure that NEC and any other relevant authorities are informed of any unanticipated or unforeseen chance-find of any precious metals or minerals or articles, that have economic, cultural, religious or ecological importance;
10. The holder shall be solely responsible for any dispute arising from the development of quarry and construction of approach road;
11. The holder shall ensure compliance to all the terms and conditions of stakeholder clearances at all times;
12. The holder shall ensure that import and use of secondhand equipment and machineries are strictly prohibited;
13. The holder shall ensure that adverse visual impacts from the development of quarry and construction of approach road are minimized at all times;
14. The holder shall ensure that felling of trees if required are done only upon obtaining approval from the Department of Forest and Park Services and strictly as per the conditions of the approval;
15. The holder shall ensure that environmentally friendly road construction technique (EFRC) is adopted while constructing the approach road to the quarry and shall be solely responsible for its proper maintenance;

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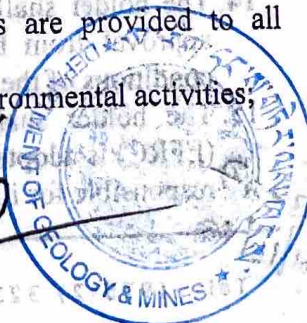
Regd. No. 3622
File No. 11/10/12
Date

NEC, P.O. Box 466, Thimphu, Bhutan
Tel: (975-2) 323384/325856/324320/326993
www.nec.gov.bt

Fax: (975-2) 323385



16. The holder shall ensure that side drains, cross drains, causeways and support structures like retaining/breast walls are constructed to prevent soil erosion and landslides;
17. The holder shall ensure that all disturbed areas along the constructed stretch of the approach road are re-vegetated by adopting different bioengineering techniques depending on the site conditions;
18. The holder shall ensure that barriers/check dams are constructed at the approved dump-sites and other necessary areas to prevent downstream environmental damages due to spillage of overburden and other debris;
19. The holder shall ensure that the development of quarry is scientific and systematic as per the approved MP and EMP;
20. The holder shall ensure that explosives are managed and used in line with the guidelines of the Ministry of Home & Cultural Affairs and Department of Geology and Mines for development of quarry and construction of approach road;
21. The holder shall ensure that explosives are used only for primary breakage adopting controlled blasting technique by certified blaster during development of quarry and construction of approach road at all times;
22. The holder shall ensure to post sentries at strategic locations to avoid mishaps during blasting;
23. The holder shall ensure that specific travel time is fixed and publicly announced in case the activities related to the quarry deters the traffic along Samdrup Jongkhar-Trashigang Highway and ensure public safety;
24. The holder shall ensure that top soil of the quarry is preserved separately and is protected from wind and rain so that it is available during re-vegetation;
25. The holder shall ensure that the overburden/excavated materials generated from the development of quarry and construction of approach road are loaded, hauled and dumped strictly at the dump-sites specified in the approved MP and EMP;
26. The holder shall ensure that proper check dams, garland drains and channels are constructed within and around the quarry and dump-sites for channeling of surface runoff water to avoid washing away of dumped excavated materials;
27. The holder shall ensure that dusts generated due to the development of quarry and construction of approach road and are adequately suppressed by spraying water at regular intervals;
28. The holder shall ensure that adequate safety gadgets and outfits such as safety helmets, eye goggles, breathing masks, ear muffs, safety boots, etc. are provided to all the workers and any other person entering the quarry;
29. The holder shall ensure that adequate sanitation facility is provided all employees and workers;
30. The holder shall ensure that general housekeeping, cleanliness and hygiene are maintained at all times at the quarry site;
31. The holder shall ensure that vehicles carrying overburden/excavated materials from the quarry and approach road are totally covered/closed;
32. The holder shall ensure that wastes generated from labour camps and offices are managed as stated in the EMP;
33. The holder shall ensure that first-aid kit is available at the site at all times;
34. The holder shall ensure that underage workers are not employed;
35. The holder shall ensure that proper health check up facilities are provided to all employees and health records are maintained;
36. The holder shall ensure that separate budget is maintained for environmental activities;



37. The holder shall ensure that safety signs are posted at the strategic locations within the Quarry, including signboards indicating the areas where specific safety gadgets are required;
38. The holder shall ensure that signboard is erected at the take-off point of the approach road to the quarry stating the name of the Quarry, Proponent and contact address of the Proponent;
39. The holder shall ensure that a copy of approved MP and EMP are made available at site at all times;
40. The holder shall ensure that a copy of this environmental clearance is framed and displayed at the work-site at all times;
41. The holder shall develop contingency plan to deal with unforeseen environmental risks, hazards & accidents and submitted to NEC **within three months** from the date of issue of this environmental clearance;
42. The holder shall ensure that environmental clearance for the operation of quarry is processed at least one month prior to completion of development of quarry and construction of approach road along with a copy of environmental clearance and a report on the implementation of its terms and conditions;
43. The holder shall ensure that renewal of this environmental clearance is processed at least one month prior to its expiry along with a copy of environmental clearance and a report on the implementation of its terms and conditions;
44. The holder shall ensure that Detailed Implementation Plan is prepared focusing the implementation of terms and conditions of this environmental clearance and submitted to NEC within **3 (three) months** from the date of issue of this environmental clearance; and
45. The holder shall ensure that the environmental unit asserts strict implementation of the terms and conditions of this environmental clearance at all times;

Failure to comply with any of the above terms and conditions shall constitute an offence under the Environmental Assessment Act 2000, its Regulations 2002, the National Environment Protection Act 2007 and any other relevant laws. Penalties for such offences shall include but not limited to suspension and/or revocation of environmental clearance in part or whole without any liability on the part of the Royal Government.

This environmental clearance is valid up to September 17, 2013 and is subject to periodic review and changes.


Chief Environment Officer
Environment Services Division

To,
✓ The Chief Executive Officer,
Natural Resources Development Corporation Limited,
Post Box no. 192,
Thimphu



Copy to:

1. The Dasho Dzongdag, Chairman, District Environment Committee, Pemagatshel for kind information.
2. The Chief Forestry Officer, Samdrup Jongkhar Forest Division, DoFPS, Samdrup Jongkhar for kind information.
3. The Offg. Head, Mining Division, DGM, MoEA, Thimphu for kind information.
4. The Chief Environment Officer, Compliance Monitoring Division, NECS for necessary action.
5. The Dzongkhag Environment Officer, Dzongkhag Administration, Pemagatshel for necessary action.
6. ~~Guard File (DGM), ESD for record.~~

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CHAPTER ONE INTRODUCTION

Crushed stone, sand and gravel are the foundations for the development of a nation. These resources are essential for building roads and highways, power plants and dams, houses, dzongs, monasteries, schools and hospitals and all sorts of construction activities. Construction aggregate, for instance, enables the farmer to grow crops and bring his goods to market on safe and efficient highways and provides the resources that enable a community to have construction materials. The stone aggregate and sand production plays a vital role in the nation's economy and in the quality of life for its residents. One can imagine the difference it makes in the quality of life with and without highways, medicines, bridges, and other necessities — all made possible with crushed stone. These resources are indispensable to the maintenance and development of rural and urban environments today. The relationship between available crushed stone and community development is essential for the maintenance and growth of our society. Without minerals from crushed stone, we wouldn't have the modern necessities that make our lives safe, comfortable and productive.

Sand ranges in size from 0.02mm to 2.0mm and is one of the principle elements used as aggregate in portland cement concrete, mortar, plaster and other building materials.

Even though stone is widely distributed throughout the country, its availability for exploitation is not easy. Some areas may lack the quality of stone, does not meet the physical-property requirements for certain uses, or it contains mineral constituents that react adversely when used in cement concrete. The others are covered by overburden that is too thick to allow economical surface mining. Further in some other areas there will be conflict in landuse as either the land is used for cultivation or important infrastructure are built on it or it forms the areas of religious importance.

The stone quarry site near Ngangsing at Tshelingor in Pemagatshel Dzongkhag has been identified and promoted by NRDCL.

With the increase in construction industry in the area specially Pemagatshel and double-laning of Samdrup jongkhar to Trashigang highway, it is envisaged that the demand for the construction stone chips and aggregates will go up significantly and the existing quarries and crushing plants will not be able to cater to the demand. With the opening of stone quarry and setting up stone crushing plant at Tshelingor by NRDCL, the shortage of the construction aggregate is expected to be filled up and the pricing will be competitive with other suppliers which will bring down the cost of construction.

The proposed quarry and the crusher at Tshelingor are expected to produce and capture at



least 50% of the demand of construction material in the radius of 100km. The quarry output shall consist of hard and compact run-off-mine quartzite lumps, and the aggregates of various sizes will be produced in the crushing plant set up by the corporation.

1.1 IMPORTANCE OF QUARRY DESIGN

It is always important to ensure the mine is correctly designed from the start. It should highlight whether there are sufficient geologic information, sound geotechnical and hydrologic information, sequential and efficient pit development and optimized haul roads and ramps. A knowledgeable mine planning is absolutely critical to a successful operation. The planning mistakes can result in very severe consequences that affect both safety and production. The knowledge of the deposit to be mined is a critical factor that can be overlooked when starting up a new project. Geological information needs to be carefully reviewed to build an accurate resource model for use in the mine design process. The collection and utilisation of accurate geotechnical data is critical in selecting the right pit slope angles. It is necessary to collect sufficient data to perform the required rock mechanics evaluation to design pit walls that remain safe and stable during operations, as the pit failures can result in buried equipment, injured employees, and lost production. Mine owners should be able to recognise issues in advance and know how to keep the mine operation going as efficiently and safely as possible.

1.2 ACCESSIBILITY

The stone quarry at Tshelingor lies very close to the highway and the quarry development site shall easily be accessible once 0.61 km of access road from existing Samdrup jongkhar-Trashigang highway to the quarry top is constructed. It is located about 4KM from the junction of Pemagatshel highway and S/Jongkhar-Trashigang highway in the direction towards Wamrong and the occurrence lies on roughly NS trending ridge line.

The exact location of newly proposed stone quarry connected by footpaths which bifurcate from the Ngangsing GREF camp located on the national highway.

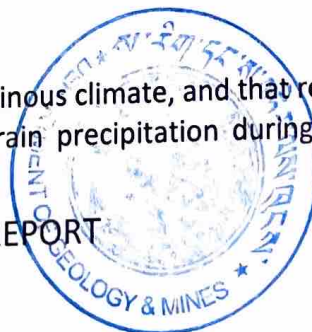
1.3 PHYSIOGRAPHY

The quartzite horizon studied for the purposed stone quarry falls under the Shumar-Daling Group of rock and which forms the part of Topo-sheet No 78 M/12 National Land Commission under Pemagatshel Dzongkhag. The topography is rugged with very steep slope on either side of the narrow ridge that runs north-south.

The perspective view of the proposed quarry site is provided in **Annexure 1.1**.

1.4 CLIMATE

The Tshelingor area lies under sub-tropical mountainous climate, and that remains quite cold in winter and humid damped summer with heavy rain precipitation during pick summer. The



working site fall in the dense jungle covered area with wide varieties of vegetations within the rain shaded zone.

The area being part of higher Himalayan region in the thick jungle covered and forms the rain shaded zone it has very thick sub-tropical vegetation as a result forms the comfortable home of wide varieties of wild animals and birds.

1.5 LEGAL AND REGULATORY CONSIDERATIONS

While carrying out the mining, processing, transporting and selling of the stone aggregates, the provisions of the Mines and Minerals Management Act 1995 and Mines and Minerals Management Regulations 2002 along with the environmental legislation shall be complied diligently, specifically the terms and conditions of the mining lease agreement and the proposal provided in this report.

The other legislation, rules and regulations that govern the mining and quarrying industry are:

- National Environment Protection Act
- Environment Assessment Act 2000
- Forest and Nature Conservation Act
- Land Act of Bhutan 2007
- Local Government Act 2009
- Labour Act
- Waste Management Act
- Explosive Rules and Regulations
- Road Act of Bhutan
- Regulations for Environment Clearance of Projects
- Guidelines for Application for Environment Clearance for Mining projects



CHAPTER TWO

MARKET

2.1 Size of market and specifications

The market for stone aggregates is growing at enormous rate with numerous development activities taking place around the country. In Pemagatshel, the prospective customer for NRDCL will be the DANTAK project which is carrying out the double-laning of Samdrup Jongkhar- Trashigang highway, and the Dentsi town development activity.

2.2 Competition in the market

At present there is one private stone quarry at Tshelingor. As on date there is no any competitor in the aggregate industry and the shortage of construction material is significant.

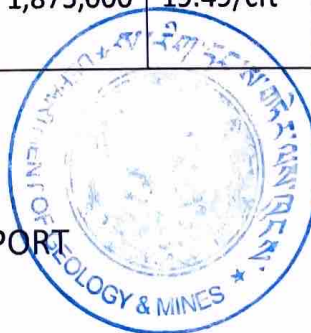
2.3 Quality control of products

The raw material used will be quartzite rocks which is one of the good quality stone used for construction. The stone from the quarry site has been tested for its suitability and strength at Standard and Quality Control Authority laboratory and the Brahmaputra Consultants and Technocrats at Guwahati. The report is enclosed as **Annexure 2.1**.

2.4 Prices

Depending on the cost of mining and the demand for the stone the price of hard quartzite lumps at the mine-head would be Nu 275 to Nu 300 per metric tonne. The prices for other aggregate sizes are as below. The conversion factor is taken as 25 cft per MT **and** the bulk density is around 1.6MT/m³. The annual quantity is based on 90% capacity utilization of 30 Tonnes per hour capacity crushing plant proposed to be set-up within a distance of 500m from the quarry boundary.

Sl No	Specification	Quantity per year (in MT)	Quantity per year (in cft)	Rate (Nu)	Total annual sale (Nu million)
1	20-40 mm	22,000	550,000	21/cft	11,550,000
2	10-20mm	18,000	450,000	23/cft	10,350,000
3	5-10 mm	18,000	450,000	19/cft	8,550,000
4	<5 mm	7,000	175,000	07/cft	1,225,000
5	Boulder	10,000	250,000	13/cft	3,250,000
	TOTAL only for aggregates	75,000	1,875,000	19.49/cft	31,675,000



CHAPTER THREE GEOLOGY AND RESERVES

3.1 Geology

The geological investigation was carried out by NRDCL with the help of expertise from the Department of Geology and Mines. The geological reserve has been estimated at 1.64 million tonnes of quartzite rock. The geological investigation report is enclosed as **Annexure 3.1**.

The main rocks in proposed stone quarry area, dominantly bedded ash-grey to dirty-white quartzite exhibiting fine to medium grained with few minor intercalations of sericitic phyllite partings, quartz veins are concentrated mainly in the phyllitic zone. The original sedimentary characters of Shumar-Daling meta-sediments have been completely obliterated because of the tectonic activities and frequent basic and acid intrusions.

The bedded quartzite exhibits very hard and compact in nature, occasionally thin laminations embedded. Physical appearance of these outcrops appears to be strong enough for use in local as well as civil engineering structures.

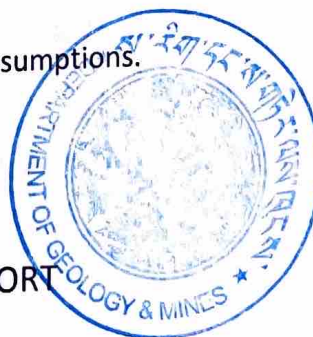
The general trend (attitudes) of rock shows strike $N45^{\circ}E$ to $S45^{\circ}W$ to $N65^{\circ}E$ to $S65^{\circ}W$ with dip amount ranges from 25° to 40° towards NW direction. However the rock, in general, shows quite brittle nature, some time gritty, exhibiting dirty/ash-white colored quartzite with friable nature. The proposed stone quarry is partially blanketed by loose-boulder and rubble of various sizes with organic decayed and wide varieties of sub-tropical vegetations. The litho sequences exposed in the identified stone quarry are highly susceptible on atmospheric weathering.

3.2 MINEABLE RESERVE

The mineable reserve is calculated based on the actual quantity of quartzite and other rocks that will be excavated from the designed pit. The geological reserve has been estimated based on 20m down dip extension based on surface assessment. However, as the quartzite bedding is expected to be continuous till the extent of designed pit the mineable reserve will be higher than the geological reserve. This shall be proven through additional studies that will be undertaken.

However to get the 100% confidence level on the stripping ratio and the quantity of good quality rock the core drilling would be preferred by any mine planning engineer, which will help in overcoming the surprises that are being encountered by many other stone quarries around the country. Alternatively, geophysical methods need to be adopted to study the thickness of overburden in the down dip extension of the quartzite bed.

The pits have been designed based on the following assumptions.



Assumptions;

- The mine reserve estimation is based on the geological map and sections and the topography map.
- Litho-contact and shear zone is as provided in the geological map.
- The general dip of quartzite rock bed is 25 to 40° towards north-west direction as reported by the geologist.
- The specific gravity of waste rock above and below the quartzite bed is 2.65.
- The overburden thickness is based on the geomorphology, geological map and sections.
- The absence of any fault in the geological map is interpreted such that the quartzite band continues down dip for the whole stretch of demarcation boundary following the same attitude of bedding.
- Final pit slope is 43° from the horizontal.
- Mining pit is constrained by the lease boundary, the terrain condition and other infrastructure available close to the quarry boundary.

The levelwise lithological volume of quartzite and overburden waste that will be excavated from the quarry are provided in **Annexure 3.2**.



CHAPTER FOUR

MINE DEVELOPMENT PLANNING

It is always important to ensure the mine or a quarry is correctly designed from the start. It is also important to highlight sufficient geologic information, sound geotechnical and hydrologic information, sequential and efficient pit development and optimized haul roads and ramps for location, proper width, access, and quality. Bad mine planning can affect safety, production and the local environment. To know the deposit the detailed geological information is important as it helps in the correct mine design process. The collection and utilisation of accurate geotechnical data is critical in selecting the correct pit slope angles to ascertain safe and stable pitwalls during operations. Pit failures can result in buried equipment, injured employees, and lost production. Designing mine plans optimise the output of the equipment being used.

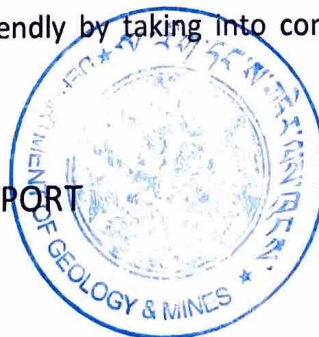
Lease area = 30.76 Acres (12.45 hectares)

The following are considered for the selection of mining method and subsequent mine planning and design:

- Scale of operation
- Quantity of Reserve
- Quantity of waste/Thickness of overburden & interburden
- Demand in the market
- Environmental considerations
- Disposition/Spatial distribution of mineral deposit
- Physical properties of rock
- Joint spacing and massiveness
- Bench parameters
- Ultimate pit slope
- Requirement of qualified and experienced manpower
- Value of stone and profitability.

The following assumptions were made while designing the mines:

- 5% of the rock excavated will go as waste in the form of undersize and dust contaminated with reject rocks and overburden.
- The quartzite is suitable for all type of construction activities.
- The quality and down dip extension are persistent at depth in the absence of core drilling.
- The annual quantity of stone requirement is 75,000 metric tonnes which is sufficient to feed the crushing plant of 30TPH capacity being set up by the company.
- The mining activity will be environment friendly by taking into consideration all the statutory requirements.



The following basic facilities shall be put in place and activities completed as a part of preliminary activities and mine development;

- Determination of pit boundary.
- Determination of the area for establishment of infra-structural facilities.
- Access road to the quarry area and the mining benches.
- Pre-production development works including jungle & bush clearance, initial cut and bench preparation to expose the deposit.
- Establishment of infrastructure that include crushing plant, machinery & equipment, office and residential buildings.
- Provision of ancillary facilities such as power, water, weighbridge, explosive magazine, transport facility etc.
- Waste dump area, along with the access to it.

4.1 Pit Boundary

The pit boundary is based on the nature of deposit, natural slope conditions of deposit, type of mineral, general dip direction of overburden & rock bed, distance from highway, and production schedule, etc. At the proposed production target the pit boundary has been determined for the 10 years lease of the quarry. The pit boundary takes into account the orientation of ultimate pit berms, length and width of the working space for heavy machinery. The design of the pit and benches is such that at any instance during mine operation the length of face is 50 metres and width is at least 18 metres.

4.2 Determination of area for establishment of infra-structural facilities

There is also ample area close to the proposed waste dump and the crushing plant where infrastructure can be set up both by the company and the quarrying contractor.

4.3 Access Road

The distances of access road from highway and crushing plant to the quarry = 0.60KM

The quarry road traffic shall be as follows:

The daily output from the mine face = 250 MT

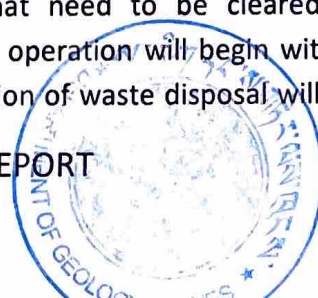
Capacity of each tipper = 10 MT

Number of tippers plying to and from the quarry and the crushing plant (two-way) = 25 round trips per day.

It will be a single lane road with passing places at interval of 150 metres.

4.4 Pre Production Development

The demarcated areas are thickly vegetated that need to be cleared off during mine development stage. Bench preparation for mining operation will begin with the initial cut at the highest elevation. The check-dam for stabilisation of waste disposal will be constructed as



per the dimension provided in the mine plan drawings.

4.5 Establishment of Infrastructure

Infrastructure development is a prerequisite for start of a mining activity. The following are the infrastructure proposed for the company:

- i. An office for company officials as per organisation chart
- ii. Office for DGM inspector at despatch checkpoint close to weighbridge.
- iii. Store for spare parts and tools
- iv. Explosive magazine: The monthly requirement of explosive is 1.50 metric tonnes. So suitably sized explosive magazine, possibly 5 MT capacity, shall be constructed so that the stock last for at least three months. The location of the magazine shall be next to waste dump area within the lease boundary.
- v. Residential hut for the security personnel guarding the explosive magazine
- vi. Residential quarters for officials and hutments for mine officials, DGM inspector(s), operators and other workers. The residential buildings will have kitchen space, cooking and drinking water provisions, toilet and proper sanitation facility.

4.6 Provision of ancillary facilities (such as power, water, weighbridge, telecommunication facility, medical facility, school facility, transport facility within and beyond the mine, etc.)

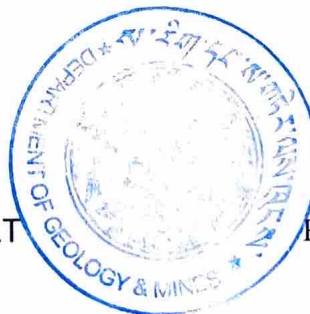
- i. *Power*: For the proposed scale of operation the establishment at mine area would be sizeable. The supply is required for crushing plant, office and colony. So the power supply needs to be provided. The crushing plant will run with electrical energy.
- ii. *Water*: The water requirement would be for cooking, drinking, washing, and for spray along the road for suppression of fugitive dust. The water is not readily available in the area and it has to be pumped up from the sources located at lower elevation.
- iii. *Transport facility*: The light vehicle for the use of quarry manager which will also serve as a utility vehicle for other purposes and a van for use by school children need to be provided.
- iv. *Medical facility*: The closest medical facility is a hospital at Riserboo in Wamrong Dungkhag of Trashigang Dzongkhag.
- v. *Survey and mapping*: To ascertain the correctness in the progress of mining the mining area has to be mapped and topography updated on a regular basis. It will also fulfil the statutory requirement for submission of annually updated plans to the Department of Geology and Mines. Survey instrument, manpower and plotting facility would be necessary which shall be serviced from head quarter in Thimphu where the facility shall be in place.
- vi. *A telecommunication facility* (walkie-talkie) shall be provided to the quarry officials and operators for easy communication which is highly essential.



4.7 Preparation of waste dump area

The overburden waste dump site will be prepared at the specified location shown on the maps. At the lower end of the proposed dump site a retaining barricade wall will be constructed which will be embedded into the ground for anchorage.

The barricade wall will have 1.5 metre width. Generally the total height of the wall shall be 2m, but will increase at places to 6m where it encounters depression area. The layout, location and length of construction of barricade wall is provided on the drawings showing first to tenth year pit plans, and it is 138 metres with total volume of 420 cubic metres.



CHAPTER 5

MINE DESIGN PARAMETERS

5.1 Bench dimensions:

Considering the provisions of the Mines and Minerals Management Regulations 2002 and the geotechnical characteristics of the area, the working and final mining benches will be 5m high with back-slope angle of 75°. The mine is designed based on the topography and the pit will advance almost perpendicular to or against the dip direction. The working benches will have width of at least 15m at the top bench. By maintaining the above bench parameters the final pit slope shall be 43° or less. In this manner due consideration has been given towards slope stability and environment protection.

5.2 Blast hole drilling:

The daily quartzite rock production capacity is 250 MT. In the first year about 8643 cubic metres of overburden will be excavated and disposed off. The drilling and blasting shall be done with deep hole drilling with bench height of 5.0 metres. The burden and spacing of the holes is proposed at 1.5 m and 2.0 m respectively and may deviate slightly based on site condition so as to prevent ground vibration and fly-rocks. Directional drilling and blasting shall be carried out to prevent fly-rock reaching the highway and the crushing plant. The direction of quarry benches is planned accordingly.

5.3 Blasting:

Blasting will be done with nitroglycerin based explosive in conjunction with ANFO, initiated by ordinary detonator and detonating fuse. As the quarry is located away from public facilities except the highway, the effect of air blast is expected to be insignificant on the settlement.

5.4 Haul road and ramp:

The haul road from the quarry face to the crushing plant shall be constructed at a gradient of 1 in 13 as the tipper trucks do not need to negotiate any uphill gradient carrying load. In order to maintain access to the mined out benches and operating benches, the narrow ramp with a gradient of not more than 1 in 10 will be maintained for people to climb up for restoration and plantation monitoring works. Such ramp is not shown on the drawings, however during actual implementation it shall be maintained.



5.5 Waste dump:

The dumping of waste rock and overburden will be done at the specified dumpsite. Barricade wall to arrest the undue erosion and maintain the stability of dump slope will be constructed. The dump will rest at the angle of repose. However where the dump height exceeds 10m there will be break in slope with width of 3 metres after every 10m vertical height.



CHAPTER SIX

MINE PRODUCTION PLANNING

The output capacity from the quarry is 250 MT per day or 75000 MT annually. It is relatively medium scale of production under the local context.

The rock deposit is not proven to high confidence level, hence the risk of getting higher quantity of reject rocks exists, which can be confirmed after the rocks are exposed.

The stone production will commence at 2440m level as this forms the ideal point from where the development can start for optimum recovery of rock. The development and removal of overburden will commence at the top portion of excavation area. The schedule of operation and production quantity during individual years from the first to the tenth year is provided in **Annexure 6.1**. The working bench levels are given for each year and the excavation will take place using top slicing method. The amount of area to be disturbed and cleared off vegetation for quarry works excluding the approach road construction is provided in **Annexure 6.2**.

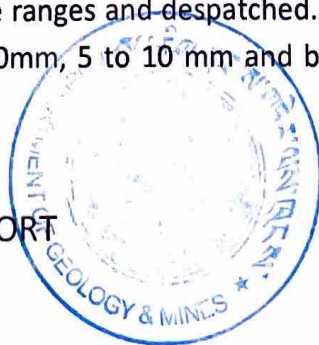
The yearwise overburden excavation and disposal is provided under **Annexure 6.3**. The levelwise fill volume and fill area in the overburden dump is provided under **Annexure 6.4**.

The index map of the area is provided in **Annexure 6.5**.

The geological map, the layout, demarcation and pre-development topography is shown in **Annexure 6.6(I)**. The mining benches are designed as shown on the maps provided under **Annexure 6.6 (II to VII)**. Mine plan drawings are attached at the end of this document. The sections have been provided along the Profile Line MM', NN' & PP' at the end of each year of quarry operation and are attached as **Annexure 6.7(A) to 6.7(M)**. The map has been plotted in 1:1000 scale and it becomes very easy for measurement to confirm the level difference and the slope.

The sequence of raising and dispatch include drilling of 5.5m blast holes of 75mm diameter, charging of holes using primer cartridge and ANFO over the 70% column length, connected each hole with detonating cord, primed by an ordinary detonator and blasted off, The blasted material will be loaded by 1m³ bucket of the excavator onto 10 Tonner Tippers and taken to the crushing plant.

Approximately 10% of the mine output of hard quartzite shall be despatched in the form of lumps directly from the quarry to the consumers. The rest of the stone shall be first transported to crushing plant, crushed to planned size ranges and despatched. The size ranges of the crushed aggregates are 20 to 40 mm, 10 to 20mm, 5 to 10 mm and below 5mm. The final output shall be despatched using public trucks.



CHAPTER SEVEN

MACHINERY AND EQUIPMENT SELECTION

7.1 The major operations in the proposed quarry include;

- a) Drilling
- b) Blasting
- c) Excavation and loading
- d) Hauling to crusher
- e) Despatch to destination

a) Drilling and blasting:

The method of drilling and blasting, bench parameters has been discussed in the earlier chapter. The requirement of drilling equipment and its accessories have been computed based on the parameters provided.

Medium diameter shot holes (75mmΦ)

Number of integrated wagon drill used	=	1
Number of holes to be drilled in two days based on production capacity	=	13
Total meterage drilling per day	=	38m
Yield per hole	=	39 MT

b) Blasting:

Daily explosive charge required	=	141 kg
Annual explosive requirement	=	42 MT
Number of ordinary detonators	=	300
Length of safety fuse required annually, in metres	=	500 m
Length of Detonating cord, in metres	=	19,000

c) Excavation and loading:

The standard excavator used in Bhutan is with 1 cubic metre bucket capacity. The calculations have been done accordingly.

Bucket capacity, cubic metres	=	1.0
Total time for loading of dumper/tipper, minutes	=	12
Excavator capacity per year	=	87000 MT
Material to be loaded per year	=	75000 MT
Number of excavators/loaders required , including waste handling	=	1

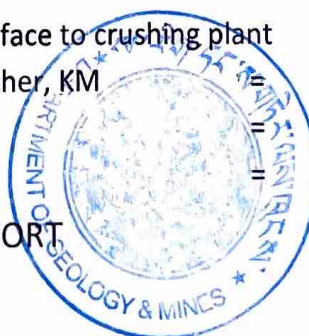
d) Hauling to crusher:

This consists of transport of quartzite from quarry face to crushing plant

Distance to be hauled between quarry face to crusher, KM = 0.6

Payload of tipper, MT = 10

Quantity to be hauled per day, MT = 250



Number of tipper loads per day	=	25
Tipper cycle time, min	=	23
Quantity hauled per day per tipper, MT	=	169
Number of tippers required,	=	2 including

requirement for disposal of overburden waste to the dump site.

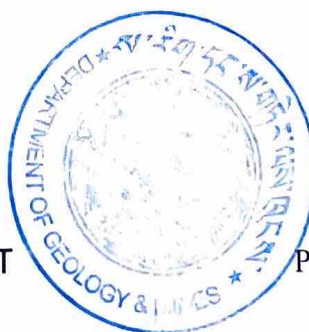
The hard quartzite broken rock shall be transported from the mining faces with the help of tippers having 10MT capacity.

e) Despatch to destination:

The transport of lumps and aggregates shall be done totally by public trucks.

f) The auxiliary equipment & facility required shall include:

- Diesel tank (12000 litres capacity)
- Explosive magazine (5 MT capacity)
- Weigh-bridge
- Water supply
- Communication set
- Light vehicle
- Water sprinkler truck
- Bus



CHAPTER EIGHT WASTE DISPOSAL PLANNING

The important aspects to be considered in waste dump management are the selection of site for dumping rejects from the mine. The waste dumpsite has been selected based on the following criteria:

- Topography of the dump site
- Extent of the quartzite band
- Output of waste and final product from the mine
- Access road to the quarries
- Method of excavation and haulage
- Drainage system at the dumpsite
- Natural drainage system and perennial water flow
- Existing land use and vegetation cover
- Stability of the area

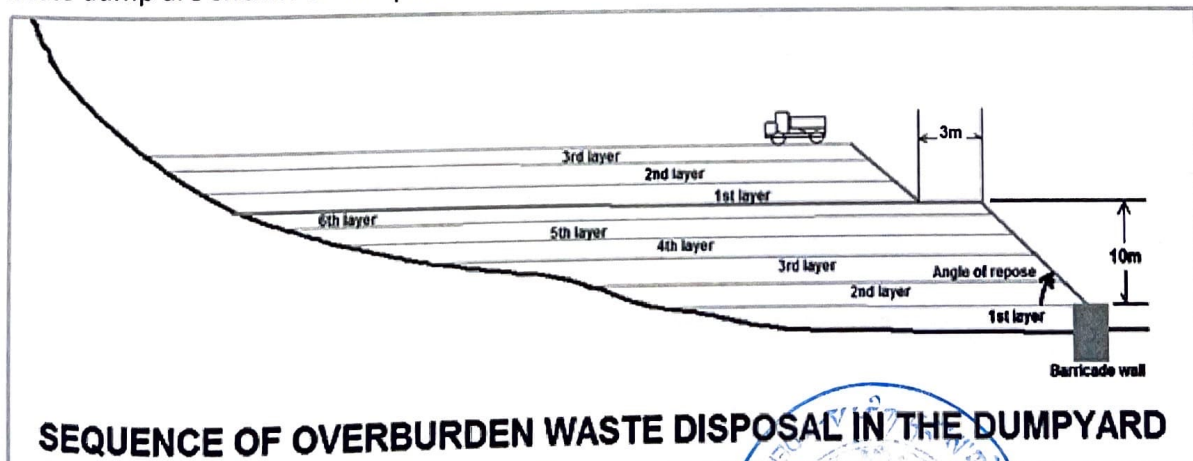
8.1 Method of overburden and waste dumping

The topography is moderately sloping in the proposed waste-dump site. The existing excavators and fleet of tippers will be used for hauling and dumping of overburden and waste to the dump site. The dumping will be done in horizontal layers and after each dumping layer the dump will be compacted with heavy equipment.

8.2 Configuration of waste dump

The waste dump shall develop like terrace with side slope resting at the angle of repose. Every after 10m high dump a terrace of width 3m shall be left to break the flow of rainwater and debris due to erosion of dumps, and for the ease of reclamation.

The top soil shall not be stored separately as there does not exist any top soil. The sites for waste dump are shown on the plans.



CHAPTER NINE

MANPOWER DEPLOYMENT AND MINE MANAGEMENT

The NRDCL management has decided that the quarry operation shall be outsourced to qualified and competent mining contractors for raising and despatch to the crushing plant. The contractors shall be made to operate the quarry in line with plans as provided in this report.

The main manpower to be recruited for environment friendly and scientific quarry operation include suitably qualified and experienced manager, foremen, supervisors and surveyor. The Project Manager shall have either the degree in Mining Engineering or Diploma in mining with practical field experience of at least three years. Other posts shall be held by the relevantly certified and experienced personnel. The helpers and casual workers shall be initially unskilled workers either employed in the regular payroll or on daily wage basis. The quarry shall be monitored periodically by the Mining Section at the company headquarters in Thimphu.

Management & Supervision (Mines)		Number
1	Project Manager	1
2	Mine Foreman (Certified and experienced)	2
3	Stores Incharge	1
4	Accountant	1
5	Office Assistant (Despatch/Time Office)	1
6	Security guards	3
7	Messenger	1
Environment Monitoring and Management		
8	Environment Supervisor/Botanist	1
9	Helpers	3
Operators		
10	Blaster	1
11	Excavator operator	1
12	Drill operator	1
13	Tipper Operator	2
14	Mechanic	1
15	Excavator helpers	1
16	Blaster helper	1
17	Drill helper	1
18	Drivers	2
19	Casual Workers (National), road maintenance crew	10
Quarry total		35

The NRDCL shall ensure that the qualification, expertise and quarrying experience of the contractor shall be given due importance during the selection of the contractor. The selection committee shall involve a senior official of Mining Division under the Department of Geology and Mines, Ministry of Economic Affairs, Royal Government of Bhutan.



During the contractor selection process the NRDCL shall draw up a proper terms of reference for the contractors. As the scale of operation is medium the NRDCL management shall also ensure that the quarrying works is continuously supervised by a qualified and experienced Project manager recruited by the contractor in order to operate the quarry in environmentally friendly manner, as per the approved Final Mine Feasibility Study report and in accordance with the terms and conditions of the environmental clearance issued by the National Environment Commission. The NRDCL shall also depute the Quarry Manager with Degree or Diploma in Mining Engineering from its side for effective monitoring of the quarrying works.



CHAPTER TEN

CAPITAL INVESTMENT

10.1 Summary of Project Cost:

Sl. No.	Details	Amount (Nu)
1	Preliminary Expenses	532,000.00
2	Mine Development	739,000.00
3	Approach Road	500,000.00
4	Infrastructure	1,500,000.00
5	Machinery and Equipment	17,050,000.00
6	Ancillary	1,500,000.00
7	Working capital	3,182,000.00
	TOTAL	24,278,000.00

Capital expenses excluding working capital	=	Nu. 21,096,000.00
Equity capital	=	Nu. 8,438,400.00
Long term Loan	=	Nu. 12,657,600.00
Debt to Equity ratio	=	3:2

10.2 Break-up of Project Cost

10.2.1. Preliminary Expenses:	~	Nu. 532,000.00
a. Geological survey and preparing geological report	=	Nu 50,000.00
b. Topographic mapping	=	Nu 292,000.00
c. Physical testing of rock quality	=	Nu 10,000.00
d. Quarry design/plans (Software cost up-loading)	=	Nu 150,000.00
e. Miscellaneous expenses	=	Nu 50,000.00

10.2.2. Mine Development: **Nu. 739,000.00**

The costs that are incurred at the quarry prior to start of actual quarry operation are incorporated as the mine-development cost. This shall include jungle clearance, overburden removal and disposal, barricade wall construction and diversion drain construction.

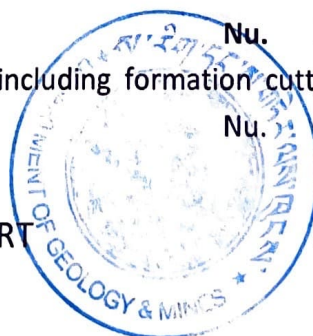
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|---|-------------|
| a) Jungle cutting and clearance, Area of 10500 m ² | Nu. 15,000 |
| b) Overburden earth excavation and disposal, | Nu. 500,000 |
| c) Construction of waste dump barricade gabion wall, 138 m long X 2m height X 1.5m width, [height above ground = 1m and below ground level= 1m] | Nu. 200,000 |
| d) Construction of catch drains (garland drains) : Digging the trench and lining with stone slabs, 30cm X 30 cm X 200m long, | Nu 24,000 |

10.2.3. Approach Road:

Construction of 0.605 km road to quarry top including formation cutting, widening, drains,

Nu. 500,000.00

Nu. 500,000.00



10.2.4 Infrastructure cost:

Nu. 1,500,000

Offices spaces	Nu 450,000.00
Stores	Nu 150,000.00
Residential	Nu 900,000.00

10.2.5. Mining Equipment

Sl. No.	Particulars	No	Rate (Nu)	Cost (Nu)
1	Excavators	1	5,500,000	5,500,000
2	Tipper/Dumper 10 tonnes capacity	2	1,400,000	28,000,000
3	Wagon drill machine	1	5,500,000	5,500,000
4	Water Sprinkler tanker	1	1,500,000	1,500,000
5	Light Vehicle	1	650,000	650,000
6	Rock breaker	1	1,100,000	1,100,000
	Total			17,050,000

10.2.6 Ancillary facilities

Sl. No.	Particulars	Cost (Nu)
1	Explosive magazine	500,000
2	Water supply	450,000
3	Office, IT equipment & Furniture	100,000
4	Communication equipment	300,000
5	Fuel tank	150,000
	Total	1,500,000

The capital cost for crusher and its accessories and infrastructure is excluded from this report.
The quarry will supply the raw material at the crushing plant site.



CHAPTER ELEVEN

PRODUCTION COST

This is the operating cost of the quarry for production of stone boulders for supply to crushing plant. It has been computed based on the scenario where the quarry is fully outsourced, with periodic monitoring by the company officials.

The details of the annual operating costs are estimated below.

11.1 Salary and Wages:

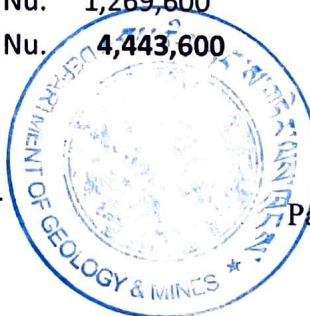
The total monthly salary and wages are computed below-

Management & Supervision		Number	Salary per head (Nu)	Total salary per month (Nu)
1	Project Manager	1	25000	25000
2	Foreman/Supervisor (certificate +10 years experience)	2	15000	30000
3	Stores In-charge	1	12000	12000
4	Accounts Officer/Accountant	1	12000	12000
5	Office Assistant (Despatch/Time Office)	1	7500	7500
6	Security guards	3	6000	18000
7	Messenger	1	5000	5000
Environment Monitoring and Management				
8	Environment Supervisor	1	15000	15000
9	Helpers	3	4500	13500
Operators & helpers				
10	Excavator operators	1	9000	9000
11	Excavator helpers	1	4500	4500
12	Tipper operators	2	7500	15000
13	Blaster	1	12000	12000
14	Drill operator	1	10000	10000
15	Drivers	2	6000	12000
16	Mechanic	1	9000	9000
17	Drill helper	1	5000	5000
18	Blaster helper	1	5000	5000
19	Casual Workers	10	4500	45000
Total Manpower requirement		35		264,500

Annual salary and wage = Nu. 3,174,000

Allowances, overtime, incentives, travel, 45% = Nu. 1,269,600

Total salary & allowance for 1st year = Nu. 4,443,600



11.2 Fuel and spares**Nu 6,574,836**

Sl. No.	Particulars	No	Total work / month	Fuel consumed (Litres)	Fuel cost (Nu)	Spare & Lub. Cost (Nu)	Total monthly Cost (Nu)
1	Excavator	1	175	3,150	129,150	64,575	193,725
2	Tipper	2	1186	474	19,452	9,726	29,178
3	Wagon drill	1	125	2,500	102,500	76,875	179,375
4	Jeep Bolero	1	1000	167	6,833	3,417	10,250
5	Water Sprinkler	1	500	250	10,250	5,125	15,375
6	Rock Breaker	1	-	-	-	-	-
7	Drill rod	5	525	-	-	60,000	60,000
8	Drill bit	5	525	-	-	60,000	60,000
	Total			6,541	268,185	159,718	547,903

Add 10% variation – contingency, per month

603,693.00

Total annual cost of fuel & spares

6,574,836.00

11.3 Repair and maintenance: Machines

This cost involves the repair and maintenance of different machinery and vehicles deployed in the mine. Assuming that the equipment cost is Nu 17 million, the estimated repair and maintenance cost per year is $0.035 \times 17,000,000 \sim \text{Nu } 595,000.00$

11.4 Repair and maintenance-Road:

For the initial 2 years the repair and maintenance of access road to the quarries has been estimated at **Nu 150,000** and increases progressively reaching **Nu 500,000** on 10th year.

11.5 Mineral levy:

The mineral levy will consist of royalty, mineral rent and surface rent. The calculations will be as follows:

Levy type	Rate	Annual Amount (Nu)
Surface rent	640	19,689
Royalty	2.2	165,000
Mineral rent	0.55	41,250
TOTAL		225,939

11.6 Environment management and re-vegetation:

A sum of **Nu 750,000** is proposed for carrying out progressive environment management and revegetation of mined out areas and stabilised waste dumps on annual basis.

11.7 Environmental restoration fund:

An annual sum of **Nu 500,000** shall be set aside as environmental restoration bond as per



requirement of regulations under Mines and Minerals Management Act 1995. This sum will be deposited in the account for environmental restoration bond fund for the first 5 years of 10 years' mining lease. In total Nu 2,500,000 shall be reserved for future mine reclamation and closure within the lease period. This total amount has been calculated and is provided in Volume II- Environment Management Plan. The additional amount is not required.

11.8 Depreciation and amortisation:

The fixed assets procured or constructed by the company will be depreciated over a period of 5-10 years. Item-wise and year-wise depreciation amount is provided in the **Annexure 11.1**. The first year depreciation amount is Nu 3.261 million.

11.9 Overhead (administrative and general) & other costs:

The annual overhead on administrative and other miscellaneous overhead have been estimated at Nu. 500,000. Thus, the annual overhead cost = **Nu. 500,000**

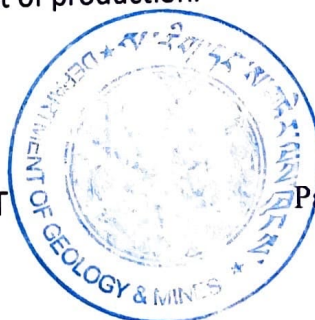
Sl. No	Explosive material	Quantity	Amount (Nu)
1	High explosive, Kg	2122	107,936.00
2	Ammonium Nitrate, Kg	14855	702,833.00
3	Detonators required per year, Nos	300	1,959.00
4	Detonating Cord, m	8370	67,937.00
5	Safety fuse required per year, metres	500	3,644.00
6	Fuel oil	-	15,000.00
	TOTAL (Annual)		899,309.00

11.10 Explosives

Summary

The cost per MT of stone from the quarry delivered at the crushing plant for a year 90% capacity utilisation = Nu 293.60
 Profit, 10% = Nu 29.36
 Sub-total landed (price) per MT at crushing plant = Nu 322.96
 Cost per cubic feet of rock landed at C.P. = Nu 12.92

Profit of 10% has been included to provide for profit of the contractor if the quarrying activity is outsourced or as profit to the corporation. The material from the quarry shall be supplied to the crushing plant. The financial analysis is carried out separately for the quarry considering it to be operated as separate activity which supplies raw material to crushing plant at **Nu 12.92** per cubic feet. The lumps shall be sold to the market at a rate of Nu 325 per metric tonne (Nu 3250 per truckload) with 10% margin of profit over the cost of production.



The cost of production of rock and delivery to the crushing plant at a distance of 600 metres is provided under **Annexure 11.2**. The unit cost of production together with the proportion of each unit cost % is also provided.



CHAPTER 12 PROFITABILITY AND CASH FLOW

The profitability statement has been generated to assess the financial viability of the quarrying project as a stand-alone project. The statement has been prepared for 10 years operation.

From the attached **Annexure 12.2**, it can be noticed that the venture is profitable from the 5th year of operation. During 2012 (1st year) the target production and sale is expected to be minimum at 50% of target capacity. The cash-flow statement is provided in **Annexure 12.2**. The Loan and its repayment and the interest are computed in **Annexure 12.3**.

The summary of financial performance is as follows:

1. Internal Rate of Return	=	15.74%
2. Net present value	=	Nu 0.92 million
3. Return on equity	=	10.74%
4. Return on investment	=	4.23%



Annexures

(PART I- FMFS)

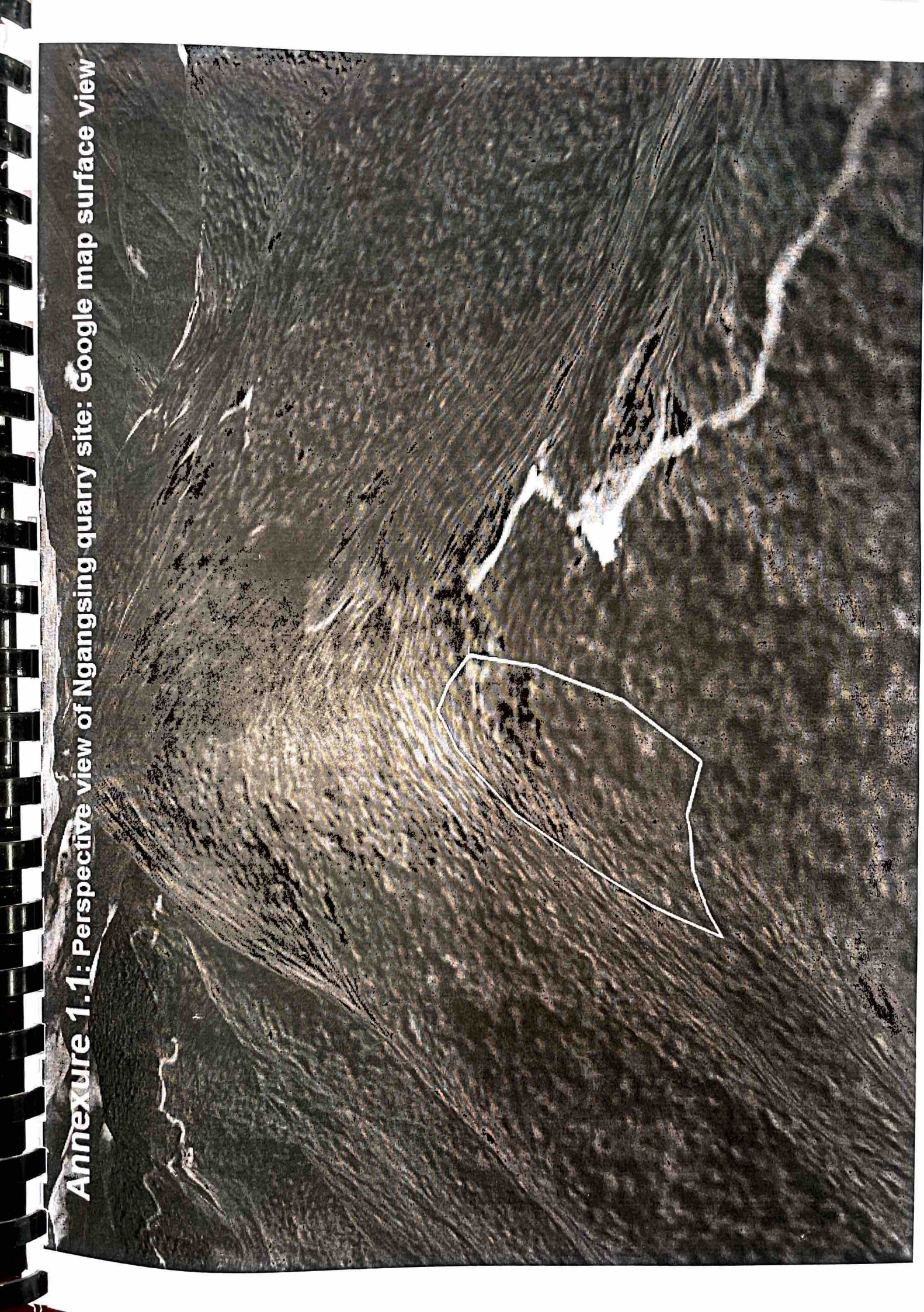


Annexure 1.1

Perspective view of quarry site



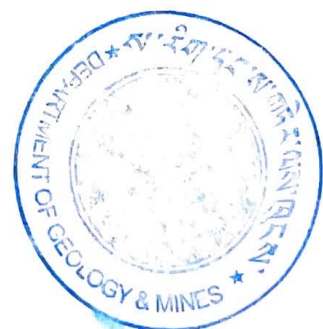
Annexure 1.1: Perspective view of Ngangsing quarry site: Google map surface view





Annexure 2.1

Stone test report





དཔལ་ལྷན་འབྲུག་གཞི་རྒྱུ
ཞབས་ཏོག་ལྷན་ཁག
གནས་ཚད་དང་རྒྱ་སྤེལ་དབང་འཛིན།

ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF WORKS & HUMAN SETTLEMENT
STANDARD & QUALITY CONTROL AUTHORITY
THIMPHU: BHUTAN



MATERIAL TESTING & RESEARCH DIVISION

Date: 6/01/2011

TEST RESULT

A. CLIENT/CUSTOMERS DETAILS:

1. Name of Client / Organization/Contractor: National Resources Development Corporation Ltd.
2. Name of works/project:
3. Location of works/project:

B. SAMPLE DETAILS:

1. Sample type/No.: Aggregate
2. Source of sample: Wamrong, Gyelposhing & Tshelingkhor
3. Collected /Inspected /delivered by: Client
4. Date collected/inspected/delivered: 23/12/2010

C. TEST DETAILS:

1. Test conducted by: Yonten Dorji, Tandin Choden & Tashi Yuden
2. Date of field test:

Sl. No.	Tests type	Results obtained	Specification as per IS codes
1	Los Angles Abrasion test		
	a) Tshelingkhor, Pemagatsel	30.27%	Refer Contract Specification
	b) Wamrong, Trashigang	39.95%	
	c) Gyelposhing, Mongar	51.97%	
2	Aggregate Crushing Value (Aggregate)		
	a) Tshelingkhor, Pemagatsel	21.16%	Refer Contract Specification
	b) Wamrong, Trashigang	25.07%	
	c) Gyelposhing, Mongar	28.89%	
3	Aggregates Impact Test		
	a) Tshelingkhor, Pemagatsel	16.8%	Refer Contract Specification
	b) Wamrong, Trashigang	21.0%	
	c) Gyelposhing, Mongar	22.58%	





དཔལ་ལྷན་འབྲེག་གཞུང་།

ཞབས་ཏོག་ལྷན་ཁག་

གནས་ཚད་དང་སྤྱི་སྡེ་དབང་འཛིན།

ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF WORKS & HUMAN SETTLEMENT
STANDARD & QUALITY CONTROL AUTHORITY
THIMPHU: BHUTAN

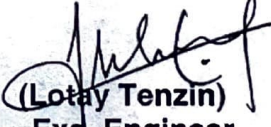


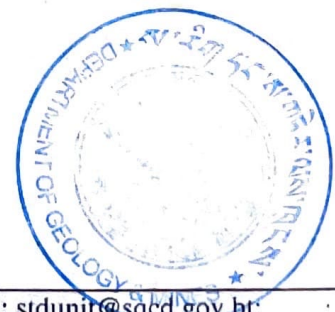
Ensuring Quality Construction

MATERIAL TESTING & RESEARCH DIVISION

4	Water Absorption		
	a)Tshelingkhor,Pemagatsel	0.63%	Refer Contract Specification
	b)Wamrong,Trashigang	0.68%	
	c)Gyelposhing,Mongar	0.73%	
5	Specific Gravity		
	a)Tshelingkhor,Pemagatsel	2.84	Refer Contract Specification
	b)Wamrong,Trashigang	2.65	
	c)Gyelposhing,Mongar	2.63	


(Tashi Pelden)
Junior Engineer


(Lotay Tenzin)
Exe. Engineer



BRAHMAPUTRA CONSULTANTS AND TECHNOCRATS

FATASIL AMBARI, GUWAHATI-781 025

(Regd. No.:RF/KM/143/514 of 1997-98)

94353-03112, 94355-52579 (M)

REF NO.: BCT/BHU/10-11/01

Date. 12/03/2011

To,

M.K. Pradhan,
Mining Specialist,
National Resource Development Corporation Ltd.,
Royal Government of Bhutan,
Thimphu, Bhutan.

Sub:- Physical tests of stone sample.

Ref. Your Letter No. NRDCL/HQ/Prod/Min/2011/619 dt. 07/03/2011

With reference to the subject cited above, please find herewith the laboratory Tests Results of Bitumen/ Emulsion/ Aggregate/Cement Physical /SOIL/ GSB/Bitumen/ Content/WBM/Strength Test/ Cube Test/ Fe Steel /Mix Design of Concrete/BMSDBC/WMM etc. samples as asked for your information and further necessary action.

Sample tested 1) Los-Angeles Abrasion Value = 9 Nos.

2) Aggregate Impact Value = 9 Nos.

3) Aggregate Crushing Value = 8 Nos.

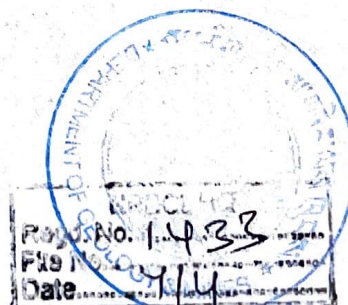
4) Specific Gravity Test = 1 No.



For M/s Brahmaputra Consultants & Technocrats

R. Singh

Scientist /Director(Tech)



BRAHMAPUTRA CONSULTANTS AND TECHNOCRATS

FATASIL AMBARI, GUWAHATI-781 025

(Regd. No.: RF/KM/143/514 of 1997-98)
94353-03112, 94355-52579 (M)

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Sub:- Physical tests of stone sample.

Name of Client:- M.K. Pradhan, Mining Specialist, National Resource Development Corporation Ltd., Royal Government of Bhutan, Thimphu, Bhutan.

Ref. Your Letter No. NRDCL/HQ/Prod/Min/2011/619 dt. 07/03/2011

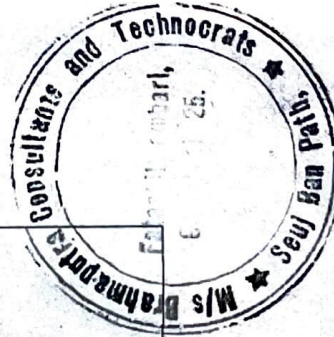
Sl No.	Identity Mark	Obtained Results				Specific Gravity Test	Specification	Remarks
		Los-Angeles Abration %	Aggr. Impact Value %	Aggr. Crushing Value %				
6	NRDCL-4a	-	25.00	-		-		
7	NRDCL-4b	18.20	-	28.66		-		
8	NRDCL-5a	30.90	-	-		-		
9	NRDCL-5b	-	-	31.20		-		
10	NRDCL-6a	25.81	27.63	24.73		-		

Sample supplied by the clients in sealed condition

Relevant Test done as per IS 2386 Pt. IV

For M/s. BRAHMAPUTRA CONSULTANTS AND TECHNOCRATS

Scientist/Director (Tech.)



Annexure 3.1

Geological report

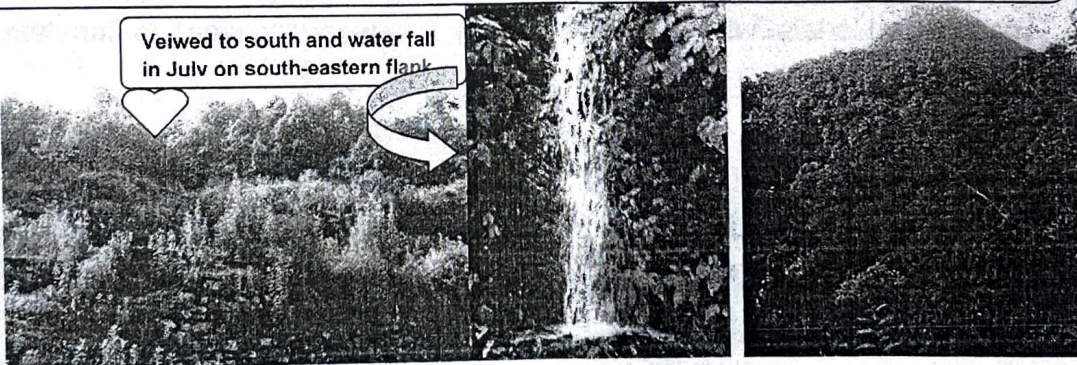


ROYAL GOVERNMENT OF BHUTAN

MINISTRY OF ECONOMIC AFFAIRS

**Report on light-gray/white quartzite occurrence (construction material)
at Tshelingkhor area, Dzongbay Geog under Pema-Gatshel Dzongkhag.**

Viewed to south and water fall
in July on south-eastern flank



Prepared:

Kharka S. Ghalley (Sr.Geologist)

GLACIOLOGY DIVISION.

Edited:

Ugyen Wangda (Head/Chief Geologist) GSB,

DEPARTMENT OF GEOLOGY AND MINES.

**HEAD/CHIEF GEOLOGIST (GSB)
DEPT. OF GEOLOGY & MINES
MINISTRY OF ECONOMIC AFFAIRS
THIMPHU : BHUTAN**



Annexure 3.1

Content

Abstract

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1.0: Introduction

1.1: Location and Accessibility

1.2: Climate and Vegetation:

1.3: Method and Objective:

2.0: Geology (regional)

2.1: Geology (Local)

2.2: Construction material.

3.0: Geo-Reserve Estimation

4.0: Conclusion

Plate 1

Location map of the light grey quartzite occurrence for stone quarry (construction material) at Tshelingkhor area, Dzongbay Geog, Pema-Gatshel Dzongkhag,

Scale 1:50,000.

Plate II

Geological, topo cum demarcation map of light-grey quartzite occurrence for stone quarry (construction material) at Tshelingkhor, Dzongbay Geog, Pema-Gatshel Dzongkhag.

Scale 1:1000 (Contour interval 5 m).

Plate III

Geo-cross sections along A'-A, B'-B and C'-C of the light-grey quartzite occurrence for stone quarry (construction material) at Tshelingkhor area, Dzongbay Geog, Pema-Gatshel Dzongkhag.

Scale 1:1000.



Annexure 3.1

Acknowledgement

Author thankfully acknowledged his sincere gratitude to Head/Chief-Geologist, GSB, Department of Geology and Mines, for constant technical guidance with supportive suggestions on both in field as well as editing report in presentable form. The author would like to extend his sincere gratitude to Director General, Department of Geology and Mines. Secondly, author also would like to thank Kalachakra Consultancy for taking care all logistic related to present assignment and making possible to complete geological & topographical-mapping works within the stipulated time period.



Annexure 3.1

Abstract

Tshelingkhor stone quarry in the Ngangsing area Dzongbay Geog under Pema-Gatshel where study conducted for stone quarry (construction material) falls within Lesser Himalayan sequence (Low Grade Meta-Sediments belonging to Shumar-Daling-Group. The rocks exposed are bedded quartzite with frequent interbandings of sericitic/schistose-phyllitic partings. It is thoroughly disturbed as a result lot of variation on foliation/strike bedding and dip angle.

The assignment was carried out on deposit work basis and field work initiated since last week of June to July .2011 vide their letter no. NNRDCL/HQ/Prod/MIN/2/2010/317 of dated 2nd December 2010. Geological mapping in the surrounding area simultaneously the detail topographical-survey were carried out on the scale of 1: 1000 with 5m contour interval covering an area approximately **12.45 hectares** exclusive of 10% of adjacent area in the proposed stone quarry. The other field data finalization like compilation, correlation and interpretation works for preparation final map, sections will be carried out in the final stage.

The main litho units in the Shumar-Daling-Group are bedded quartzite, and variegated phyllite calc quartzite with few basic and ultra-basic outcrops at certain locations. Because of intense tectonic activities the top portion of the mapped area shows tension-cracks, voids caves along ridge line, exhibiting complicated geo-structures (SK Roy 1978).

The bedded (massive) gritty quartzite with numerous interbandings of variegated phyllite, chloritic carbonaceous phyllite with frequent secondary intrusions. The over burden ratio appears to be comparatively low with organic decayed/surface weathering.

The general attitude of rock shows strike ranging from $N40^{\circ}E-S40^{\circ}W$ to $N65^{\circ}E-S65^{\circ}W$ and dip amount ranging from 35° to 45° towards NW and NE direction. However, the area is blanketed by moderately thick common soil (organic decayed) with few huge boulders especially around the DP-8 and wide verities of sub-tropical vegetation.

Geo-reserve has been estimated approximately **1.64 million tones** based on surface geo-field data gathered from ground work using the geological cross sectional method.



Annexure 3.1

1.0: Introduction

Department of Geology and Mines has conducted the detail study on the quartzite occurrence (construction material) at Ngangsing area in Tshelingkhor Dzongbay geog under Pema-Gatshel Dzongkhag, to open the stone quarry for construction purpose.

1.1: Location and Accessibility

The quartzite horizon studied for the purposed stone quarry falls under the Shumar-Daling-Group of rock and which forms the part of Topo-sheet No 78 M/12 National Land Commission with geographical coordinates:

North Latitude: 2892550—1031050

East Longitude: 2892800 --2893150

Construction material occurrence lies on roughly NS trending ridge line at 6km ahead of Pema-Gatshel bifurcation stone point on the Trashigang--S/Jongkhar national highway.

Investigated area can be accessible from Ngangsing that lies on National Highway at 74 km stone point from Samdrupjongkhar, and the exact location of newly proposed stone quarry connected by footpaths which bifurcate from the Ngangsing GREF camp located on the national highway.

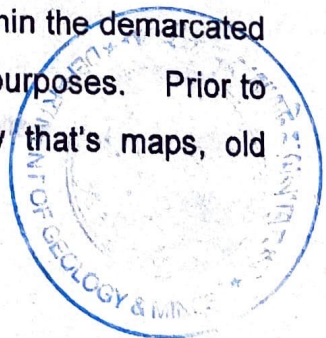
1.2: Climate and Vegetation:

The area lies under sub-tropical mountainous climate, and that remains quite cold in winter and humid damped summer with heavy rain precipitation during pick summer. The working site fall in the dense jungle covered area with wide varieties of vegetations within the rain shaded zone.

The area being part of higher Himalayan region in the thick jungle covered and forms the rain shaded zone it has very thick sub-tropical vegetation as a result forms the comfortable home of wide varieties of wild animals and birds.

Objective and Method:

Main objective is to carry out detail geological and topography survey on scale 1' 1000 wherever the outcrop appears to be more promising or economically viable, and also to determine the quality as well as the quantity of material available within the demarcated area, and are considered for suitable raw materials for construction purposes. Prior to proceed field, author collected the references from DGM Library that's maps, old



Annexure 3.1

literatures, whatever the previous data available in the DGM. Thereafter left for field camp with necessary equipments to Tshelingkhor Ngangsing camp Dzongbay Geog under Pema Gatshe Dzongkhag.

In order to find out geologic set-up of the region several geo-traverses conducted tracing the rock types as well as measurements of the orientation of bedding foliations on exposed outcrops, simultaneously an environment impacts on surrounding areas have also been taken due account from the geological point of view.

1.3: Geomorphology,

Bhutan forms a part of higher Himalayas that's continuous chain of younger mountain ranges of Eastern Himalayas. Landscape pattern mostly controlled by erosion activities, drainage system and geo-structural phenomena including the frazzled litho succession. The prominent ridges are frequently dissected by the geo-structural lineaments as well as perennial river systems into deep gorges and valleys.

2.0: Geology (Regional):

Bhutan has complicated stratigraphy caused by intense folding, faulting, thrusting, and highly variable grade of metamorphism. The unfossiliferous rock formations have added to the extreme difficulties to establishing in its normal geo-chronological order. The stratigraphy succession are gradually grading from molassic sediments to high grade migmatite gneiss, para-gneiss, garnet biotite schist and silliminite schist level and they are not only difficult but impossible to interpret by normal field method (Jangpangi et al 1960-1963).

Thimphu Series: Ortho and Para- gneisses Darjeeling Himalayas Pre- Cambrian
-----Thrust-----

Paro Series Marbles and Calc-silicate rocks, intruded
basic bodies (rock) and occasional pegmatite. Pre- Cambrian

-----Thrust-----

Shumar Series Gypsum- bearing phyllite and
Phyllitic slates, limestones, Daling series Pre- Cambrian
Flaggy & massive quartzites.

--- Massive quartzites, interbended minor phyllitic and basic sills---



Annexure 3.1

Samtse: Quartzite Unit

Phyllitic unit	Sericitic, chlorites phyllites with	Daling	Pre- Cambrian to
	Sericitic, chlorites phyllites with	Daling	Pre- Cambrian to
	Copper mineralizations, grey-phyllites, calcite quartzites and basic sills.	Daling	older palaeozoic

-----Thrust-----

Buxa	Thick boulder beds of duiri, carb. Phyllites quartzites massive Dolomites and felspathic sandstones.	Blaini Krol-Tal Series of Kumaon	Permo-Traissic
------	--	----------------------------------	----------------

-----Thrust or Unconformity-----

Phuentsholing Series	Purple and green phyllites quartzites, Conglomerates, Thick carbonaceous phyllites with sills and dykes.	Purple Series Jaunsars	Middle Palaeozoic
----------------------	--	------------------------	-------------------

-----South-----

Gondawana sediments (sequence) has been superimposed by boulder-slate, pebbly-phyllite and gray-slatty horizon of Duiri Formation and that's sequentially followed by Daling-Shumar Group of rocks like variegated colored phyllite dolomite limestone and white felspathic quartzite sequences with occasional conglomerate bands (A. Ganser 1983).

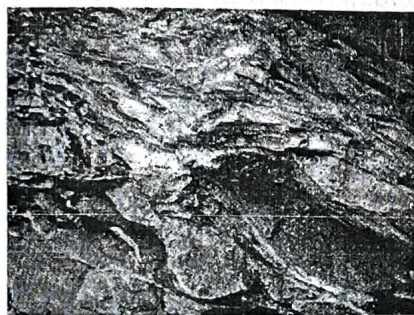


The best-exposed section of Shumar-Daling Sequence found along Shumar-KharungLa in Trashigang Dzongkhag (Dasgupta, 1994). North of this range the meta-sediment represented as cyclic sequence that is frequently intercalated with quartzite, phyllite, marble, limestone and calc-quartzite. Shumar allochthonous sediment has been studied by several geologists in different times in their field session.



Annexure 3.1

Shumar-Daling-meta-sediment has been divided into seven members (bottom to top alphabetically from member A to member G by (SK Roy 1978). In general rock in this region is represented by an alternating (almost cyclic) sequence of phyllite and quartzite with thin but persistent bands of crystalline limestone and occasional zone of highly carbonaceous phyllite associated with chloritic-phyllite and some lensoids of massive magnetite laminae of pyrite (Roy1978). Frequent repetition of litho units is common because of repeated folding and faulting. The studied area for proposed stone



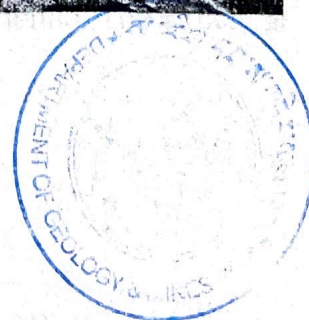
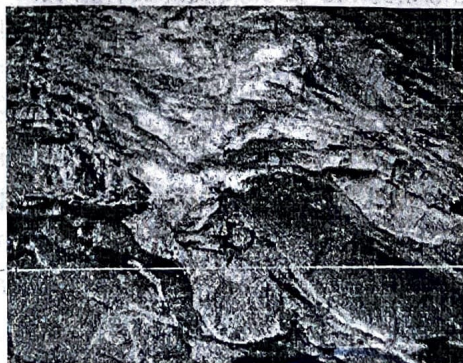
quarry lies near Ngangsing which may be the part of Moshi-Nanung-synform zone and the synfomal geo-



structure roughly trending NS direction falls in the vicinity of NE-SW trending thrust contact (marked by Earlier worker) between Shumar-Daling-Group of rock and Buxa Group of rock. Shumar-Daling Group of rock occur as an over-thrusted mass on Thungsing Formation with zone of shattered and fractured quartz slates marking the thrust plane slightly further below the Ngangsing area. Prominent regional geo-structure marked as Tokarong-Brekha dragged fault which has tiered and shifted the carbonate sequence (dolomite)

from Norphung to Brekha area (SK Roy 1994). The composition, fabric, texture that influence the physical and chemical behavior of the rocks and soils. These attributes are important in determining the shear strength, permeability, susceptibility to chemical and physical weathering, which affects the stability of the area.

Higher Himalayan meta-sediments are made up of various tectonic set-up along major geo-sections and express themselves, as Lower (Lesser) Higher (Greater) Himalayan sequence under three major physiographic sub-divisions and these tectonic divisions are separated from each other by the low angle fault/Thrust (B.S.Jangpangi 1983-84).



2.1: Rocks of proposed quarry.

The main rocks in proposed stone quarry area, dominantly bedded ash-grey to dirty-white quartzite exhibiting fine to medium grained with few minor intercalations of sericitic phyllite partings, quartz veins are concentrated mainly in the phyllitic zone. The original sedimentary characters of Shumar-Daling meta-sediments have been completely obliterated because of the tectonic activities and frequent basic and acid intrusions.

The bedded quartzite exhibits very hard and compact in nature, occasionally thin laminations embedded. Physical appearance of these outcrops to be strong enough for use in local as well as civil engineering structures. The rock strength, aggregate durability with atmospheric condition, abrasive value of aggregates and resistance to withstand longer period on atmospheric condition



The mineral assemblages in this horizon are essentially of quartz, feldspar, biotite and muscovite and show intense effect of shearing, faulting and folding. Quartzite band as construction blocks (slabs) is basically determined by spacing of joint pattern within each set and in soft rocks where deformation occurs independently and degree of joint has less importance than it normally has in hard rock, however the tectonic stress can be more influential in the area, as the identified stone quarry lies in the vicinity of lineament zone along Neyra Ama valley (Roy & et.al.73-74). However there are numerous other partings which is below the plottable size and these minor laminations represents as thin arenaceous/arkosic layers in the massive quartzite expressed the orientation of foliation/bedding planes.

Besides the regional and local geology, type of material with its susceptibility to atmospheric weathering, quality and quantity and economically workable rank of material has been taken into account. A few photographs were taken during the investigation and these are attached for ready reference with report. The general trend (attitudes) of rock shows strike N45°E-S45°W to N65°E-S65°W with dip amount ranges from 25° to 40° towards NW direction. However the rock in general shows quite brittle nature, some time gritty, exhibiting dirty/ash-white colored quartzite with friable nature. The proposed stone quarry is partially blanketed by loose-boulder and rubble of various sizes with organic decayed and wide varieties of sub-tropical vegetations. The litho sequences exposed in the identified stone quarry are highly susceptible on atmospheric weathering. The structural



Annexure 3.1

discontinuities like shearing, joint fracture undulations and wrapping are commonly observed on exposed outcrops.

Water spring location on S./eastern flank of NS ridge line (DP-7) pick time discharge size seems to be enough but how long it remains. Another small well (water) without flow at (DP-1).

3.0: Construction material



The material of value that man extract from earth in order to carry out their development activities are some of the industrial rock and mineral. Rocks whether directly or indirectly used in industrial purposes are in commercially term industrial rock and mineral, on other hand rock which has high value and having high weathering resistance or can withstand prolong atmospheric condition that's considered as deposit for construction material, thus they have their own commercial rank in different industries. Beside that for physical characteristic of rock, the client has to conduct series of geo-technical test to meet the required specification for standardization of construction material (aggregates). Usually the quality of material depends on the individual project specification published by user organization. The mining engineer associated in the team to carry out related issues like mining viability, instability of access road with related environmental impact posed by mining activities and to demarcate the leasing area for stone quarry. The rock-outcrops are physically checked on the spot to determine the material quality, and to assess total workable material available in area with some effective recommendation on environment impact posed by mining activities.



Annexure 3.1

Geological reserve

Tshelingkhor quartzite occurrence covered-up the complete mapped area with cumulative thickness of hard stone approximately 150m. Geo-reserve is estimated using the cross sectional method. Three geo-cross sections were drawn across geo-strata sequentially from SE to NW. The area of influence has been taken as half distance on either side of section line. Overburden (including organic decayed) ratio may reduce depending upon mining bench-height. Depth persistence along dip is assumed depending upon cliff (Outcrop) on the slope (15 meters) to estimate geo-reserve. It is therefore, total extractable material from demarcated & leased area has been estimated taking the average density of quartzite 2650kg/m. The reserve figure given is based on surface geo-data interpretation only.

Reserve table (Geo-Section A'----A)

SL No	Geo/ section	Strike Length	Thicknes (m.)	D/Persi stance	Sp.Gr	Metric tones
1	First (1) band	150.00	60.00	15.00	2.65	357750
2	2 nd (2) band	150.00	30.00	15.00	2.65	178875
3	3 rd (3) band	150.00	40.00	15.00	2.65	238500
4	4 th (4) band	150.00	40.00	15.00	2.65	238500
						1013625

Reserve table (Geo-Section B'---B)

SL	G/section	Strike/L	Thicknes	D/Pers.	Sp.Gr	Metric tones
1	First (1) band	130.50	55.00	15.00	2.65	284212.5
2	2 nd (2) band	130.00	35.00	15.00	2.65	180862.5
3	3 rd (3) band	130.00	25.00	15.00	2.65	129187.5
4	4 th (4) band	130.00	75.00	15.00	2.65	387562.5
						981925.00

Reserve table (Geo-Section C'---C)

SL	G/section	Strike/L	Thicknes	D/Pers.	Sp.Gr	Metric tones
1	3rd(3) band	150.50	25.00	15.00	2.65	149062.5
2	2 nd (2) band	150.00	10.00	15.00	2.65	59625
3	3 rd (3) band	150.00	30.00	15.00	2.65	178875
4	4th(4) band	150.00	80.00	15.00	2.65	477000
						874562.5

Total geo-reserve figure without any deduction is **1957852.5** construction material estimated from four geo-cross sections drawn across strata.



Annexure 3.1

After allowing 15% deduction on fractures, void, other fluctuations including the safety margin towards estimation-error, the extractable geo-reserve worked-out 1.64million tones. Geological-reserve figure as mentioned in column is estimated based on surface geological-data interpretation. No any sub-surface data incorporated; therefore author is not responsible for any major variation that might occur during actual excavation.

5.0: Conclusion

Tshelingkhor-stone quarry Dzongbay located almost along the national highway can be reached by a few hundred meters footpath to working site (Samdrupjongkhar Trashigang highway) It is located four km ahead of Pema Gatsel road bifurcation point based camp at Ngangsing (74 Km stone point) from Samdrupjongkhar.

Quartzite occurrence at Tshelingkhor-area physically appears to be strong enough for local and as well as any other civil engineering works for construction purposes. The quartzite posses' high hardness/toughness/brittle types with compact in nature as a result rock seems to be resistance to withstand longer enough duration on atmospheric weathering.

The construction material produced from any stone quarry may contain variable amount of unwanted materials (fines particles) which depends upon various reasons on source-rock.

For the wider range of standard specification of building material, the rock/stone to be tested series of geo-technical parameters to meet the required specification by the consuming organization which depends upon type of civil engineering structures with their own standard specifications.



Location map of the light grey quartzite occurrence for stone quarry (construction material) at Tshelingkhor area, Dzongbay Geog, Pema-Gatshel Dzongkhag,

Scale 1:50,000.

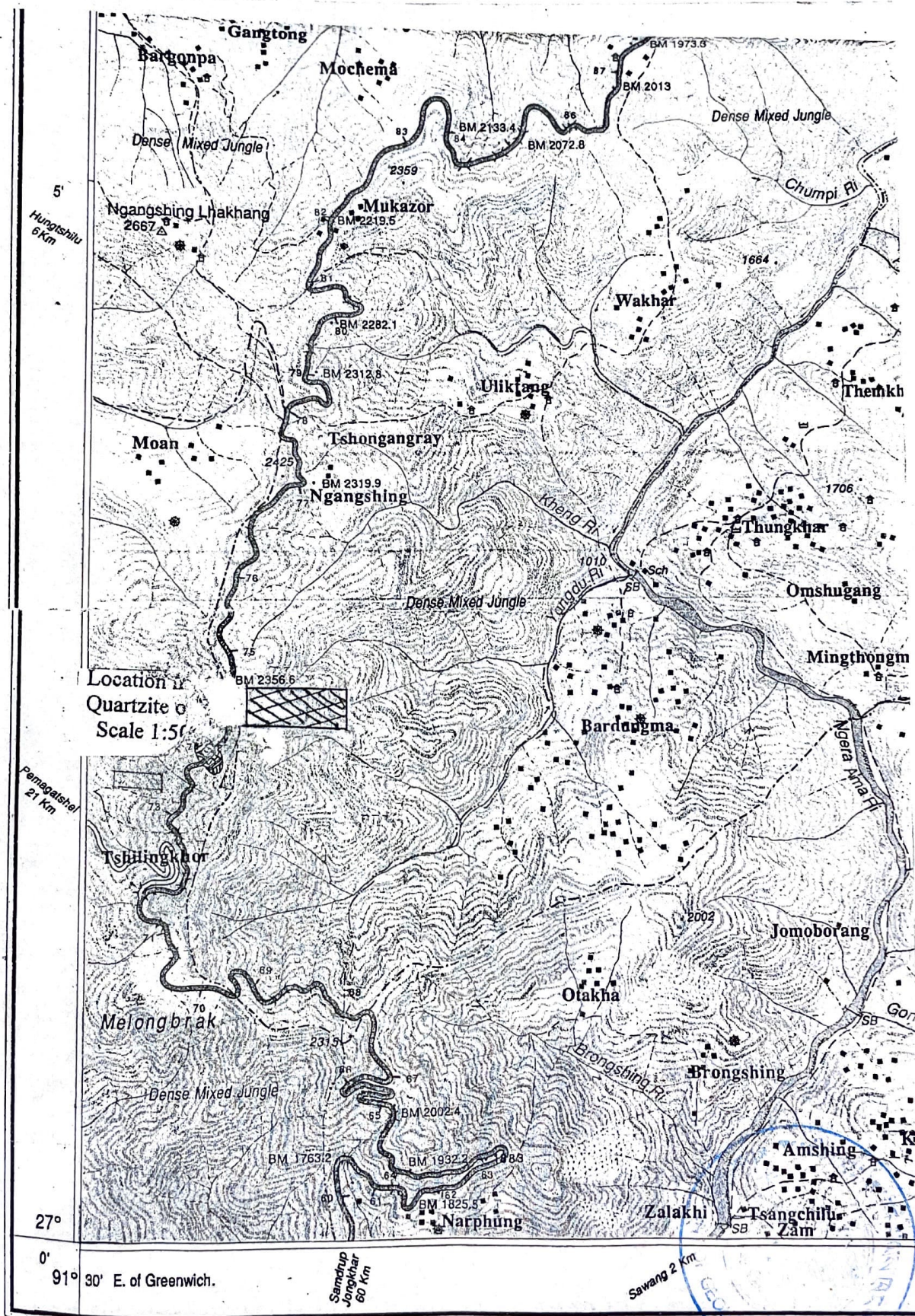
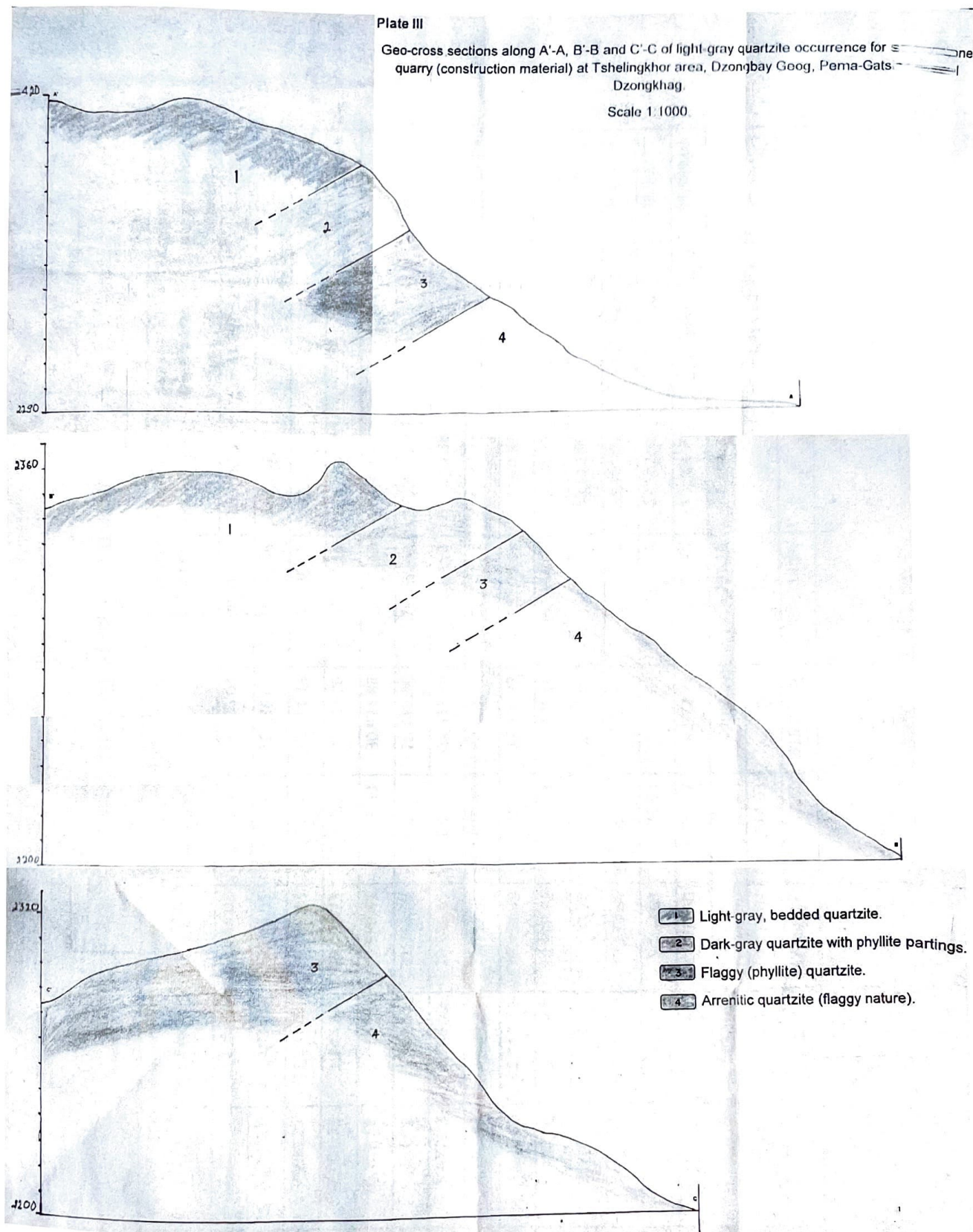


Plate III

Geo-cross sections along A'-A, B'-B and C'-C of light-gray quartzite occurrence for the quarry (construction material) at Tshelingkhor area, Dzongbay Geog, Pema-Gats, Dzongkhag.

Scale 1:1000.



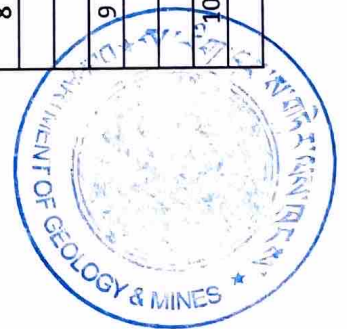
Annexure 3.2: Levelwise recovery of Stone and Waste

From m (AMSL)	To m (AMSL)	Avg. Cut Area (m ²)	Overburden Area (m ²)	Cut Volume (m ³)	Overburden Volume (m ³)	Rock Volume (m ³)	Rock Tonnage (Metric tonnes)	Cum Cut Volume (m ³)	Cumulative Overburden Volume (m ³)	Cumulative Rock Tonnage (Metric tonnes)
2360	2365	7,752.81	1,295.22	38,764.03	1,438.42	37,325.61	98,912.87	357,061.28	41,997.52	834,918.96
2365	2370	7,565.19	1,182.01	37,825.95	1,689.10	36,136.85	95,762.66	318,297.25	40,559.11	736,006.08
2370	2375	7,293.25	1,281.97	36,466.23	2,115.10	34,351.13	91,030.49	280,471.30	38,870.01	640,243.43
2375	2380	7,001.75	1,244.84	35,008.73	2,272.03	32,736.70	86,752.24	244,005.07	36,754.91	549,212.93
2380	2385	6,717.68	1,186.93	33,588.41	2,616.53	30,971.88	82,075.48	208,996.34	34,482.87	462,460.69
2385	2390	6,352.71	1,302.41	31,763.57	3,022.21	28,741.36	76,164.60	175,407.93	31,866.34	380,385.21
2390	2395	5,677.33	1,755.72	28,386.65	3,834.75	24,551.90	65,062.53	143,644.36	28,844.13	304,220.61
2395	2400	4,751.48	1,630.57	23,757.40	3,625.99	20,131.41	53,348.24	115,257.71	25,009.38	239,158.09
2400	2405	4,099.80	1,244.61	20,498.99	3,174.60	17,324.39	45,909.63	91,500.31	21,383.39	185,809.85
2405	2410	3,737.76	1,038.57	18,688.82	2,313.73	16,375.10	43,394.00	71,001.32	18,208.79	139,900.22
2410	2415	3,316.24	1,249.95	16,581.18	3,200.24	13,380.95	35,459.50	52,312.50	15,895.06	96,506.22
2415	2420	2,435.79	1,349.46	12,178.96	4,051.63	8,127.33	21,537.42	35,731.32	12,694.83	61,046.71
2420	2425	1,930.13	1,118.65	9,650.63	2,276.94	7,373.69	19,540.28	23,552.36	8,643.20	39,509.29
2425	2430	1,441.50	1,045.50	7,207.50	2,234.77	4,972.74	13,177.75	13,901.73	6,366.26	19,969.01
2430	2435	996.04	857.01	4,980.20	2,417.46	2,562.74	6,791.26	6,694.23	4,131.49	6,791.26
2435	2440	342.81	342.81	1,714.03	1,714.03	-	-	1,714.03	1,714.03	-
Total		71,412.27	19,126.23	357,061.28	41,997.52	315,063.76	834,918.96			



Annexure 6.1: YEARWISE PRODUCTION SCHEDULING FOR 10 YEARS

Year	From m (AMSL)	To m (AMSL)	Overburden Volume (m ³)	Rock Volume (m ³)	Rock Tonnage (Metric tonnes)	Cumulative Overburden Volume (m ³)	Cumulative Rock Tonnage (Metric tonnes)
1	2435	2440	1,714	-	-	1,714	-
	2430	2435	2,417	2,563	6,791	4,131	6,791
	2425	2430	2,235	4,973	13,178	6,366	19,969
	2420	2425	2,277	6,615	17,531	8,643	37,500
2	2420	2425	-	758	2,009	-	2,009
	2415	2420	4,052	8,127	21,537	4,052	23,547
	2410	2415	3,200	12,341	32,703	7,252	56,250
3	2410	2415	-	1,040	2,756	-	2,756
	2405	2410	2,314	16,375	43,394	2,314	46,150
	2400	2405	3,175	8,057	21,350	5,488	67,500
4	2400	2405	-	9,268	24,560	-	24,560
	2395	2400	3,626	19,034	50,440	3,626	75,000
5	2395	2400	-	1,097	2,908	-	2,908
	2390	2395	3,835	24,552	65,063	3,835	67,971
	2385	2390	3,022	2,653	7,029	6,857	75,000
6	2385	2390	-	26,089	69,135	-	69,135
	2380	2385	2,617	2,213	5,865	2,617	75,000
7	2380	2385	-	28,302	75,000	-	75,000
8	2380	2385	-	457	1,211	-	1,211
	2375	2380	2,272	27,845	73,789	2,272	75,000
9	2375	2380	-	4,892	12,963	-	12,963
	2370	2375	2,115	23,410	62,037	2,115	75,000
10	2370	2375	-	10,941	28,993	-	28,993
	2365	2370	1,689	17,361	46,007	1,689	75,000



Annexure 6.2: AREA USED FOR YEARWISE QUARRY OPERATION

Year	Area Excavation (m ²)	Cumulative area (m ²)
1	3,367	3,367
2	2,551	5,918
3	1,971	7,889
4	1,934	9,823
5	2,374	12,197
10	5,264	17,461



Annexure 6.3: LEVELWISE OVERBURDEN EXCAVATION DISPOSAL

Year	From (m AMSL)	To (m AMSL)	Overburden Volume Insitu (m ³)	Overburden Volume Loose (m ³)	Loose Overburden Cumulative (m ³)
DS	2440	2430	4,131.49	5370.94	5,370.94
1	2440	2420	4,511.71	5865.22	11,236.15
2	2420	2410	7,251.87	9427.42	20,663.58
3	2410	2400	5,488.33	7134.83	27,798.41
4	2400	2395	3,625.99	4713.79	32,512.19
5	2395	2385	6,856.97	8914.06	41,426.26
6	2385	2380	2,616.53	3401.49	44,827.74
7	2380	2380	0.00	0.00	44,827.74
8	2380	2385	2,272.03	2953.64	47,781.38
9	2375	2380	2,115.10	2749.63	50,531.01
10	2370	2375	1,689.10	2195.83	52,726.84
11	2365	2370	1,438.42	1869.95	54,596.79



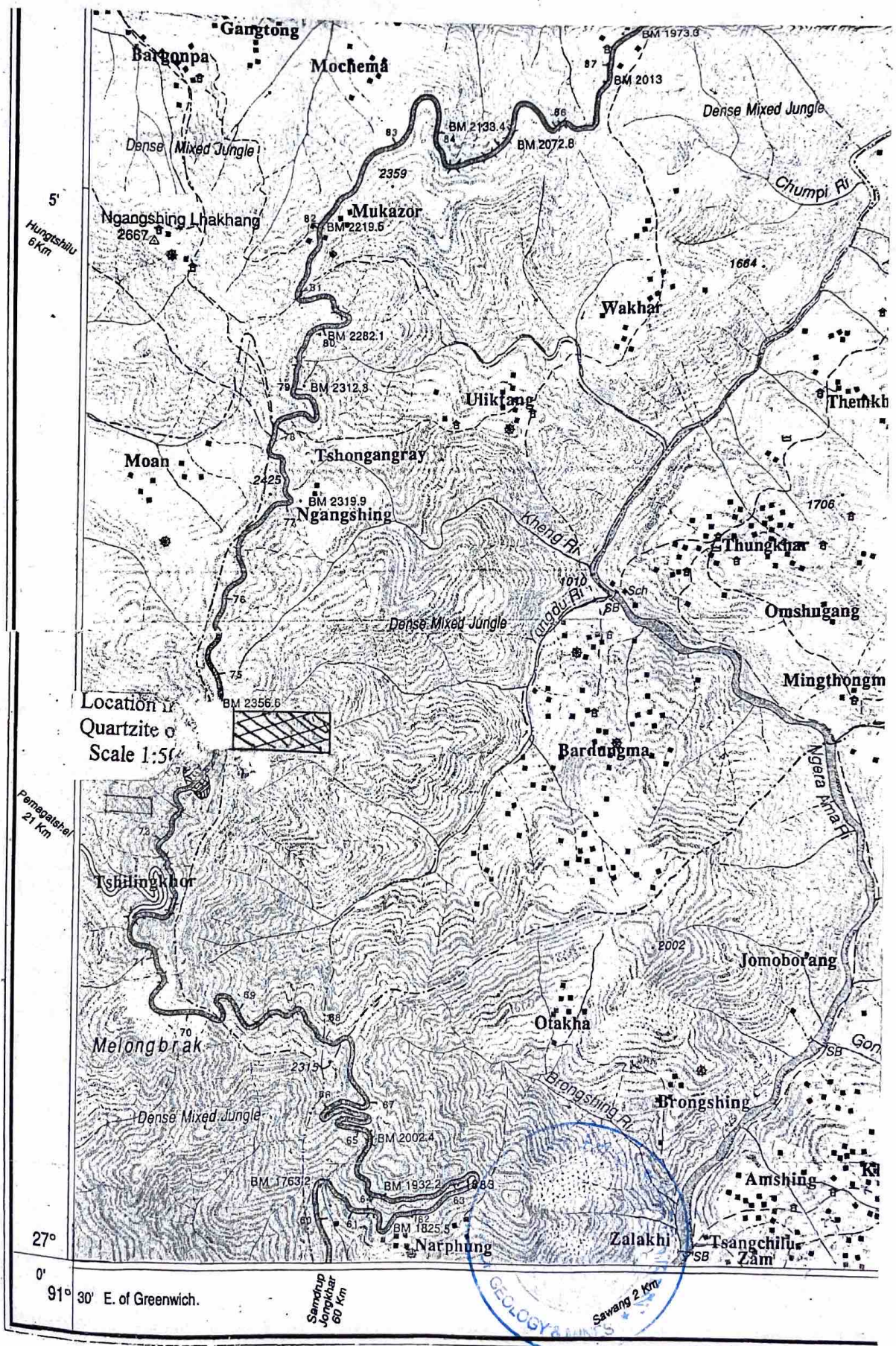
Annexure 6.4: LEVELWISE OVERBURDEN DUMP FILL AREA AND VOLUME

From	To	Fill Volume (m³)	Fill Area (m²)	Cumulative Fill Volume (m³)
2285	2290	218.83	43.77	218.83
2290	2295	2649.04	529.81	2867.87
2295	2300	8200.14	1640.03	11068.01
2300	2305	10755.38	2151.08	21823.39
2305	2310	11948.03	2389.61	33771.42
2310	2315	10009.36	2001.87	43780.79
2315	2320	9135.35	1827.07	52916.14
2320	2325	4263.93	852.79	57180.07
2325	2330	1957.15	391.43	59137.22
Total		59137.21	11827.46	



Annexure 6.5

Index map of the proposed quarry site at Ngangsing in Tshelingor area,
Zobel Gewog, Pemagatshel Dzongkhag

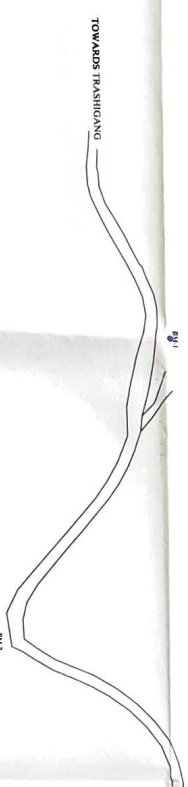
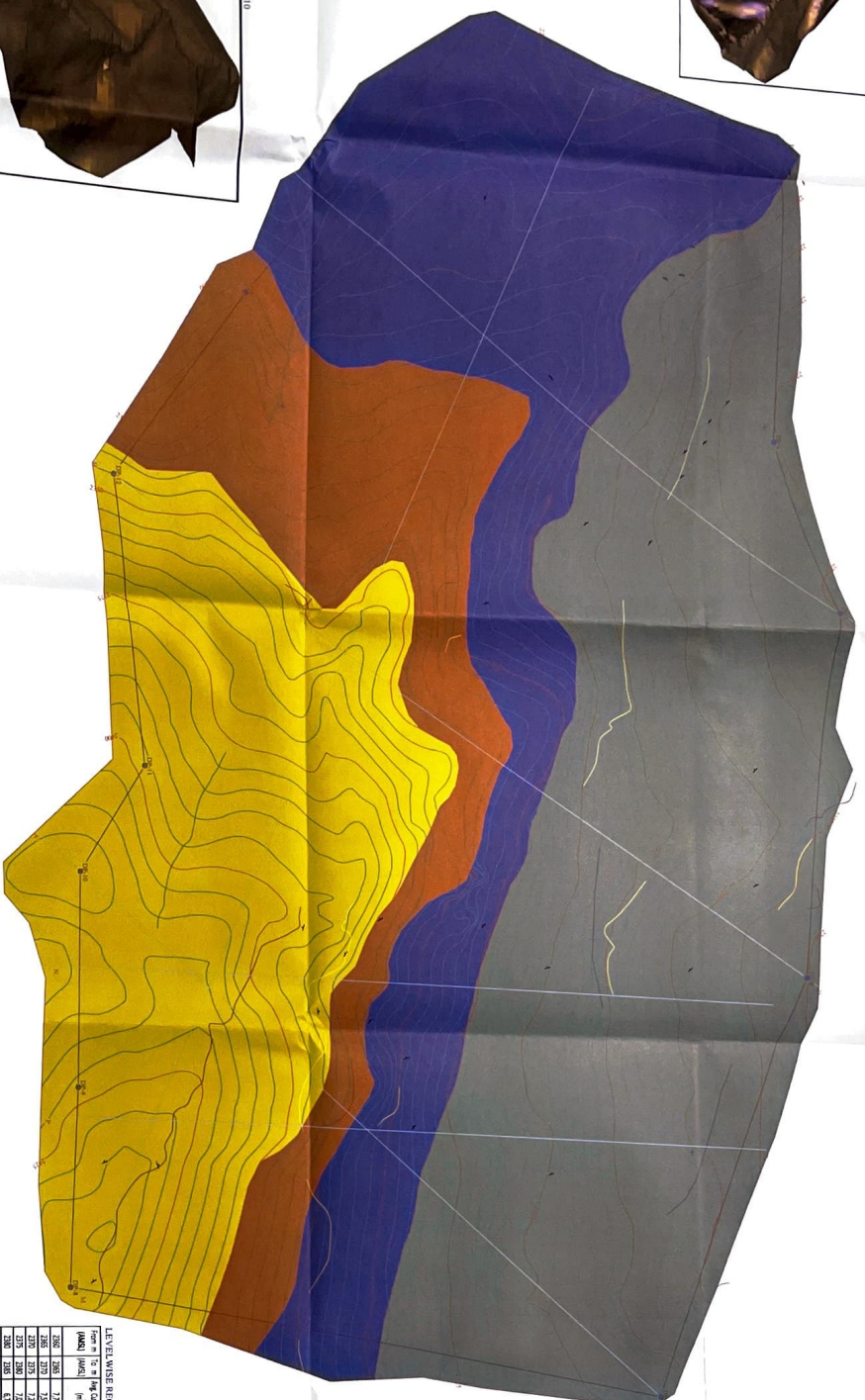
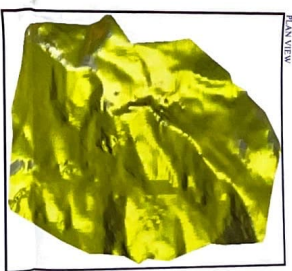


Annexure 6.6

(I TO VII)

Drawings



[illegible]

NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED

PRE-DEVELOPMENT QUARRY PLAN
 NGANGSING STONE QUARRY, TSHELINGOR
 ZOBEL GEWOG, PEMAGATSHEL DZONGKHAG

SCALE	1 : 1000	LEASE AREA	(2.4 ha (5.97 % area))	SURVEYED BY	HEMRA CHETRI
DRAWING NO	ANNEXURE 6A01	DATE	JUNE 2012	DEBAGATED BY	BINISH PRADHAN
SCALE BAR					CHECKED BY K.S. CHALLY ADAPTED BY M.K. PRADHAN

SCALE	1 : 1000	LEASE AREA	(2.4 ha (5.97 % area))	SURVEYED BY	HEMRA CHETRI
DRAWING NO	ANNEXURE 6A01	DATE	JUNE 2012	DEBAGATED BY	BINISH PRADHAN
SCALE BAR					CHECKED BY K.S. CHALLY ADAPTED BY M.K. PRADHAN

SCALE	1 : 1000	LEASE AREA	(2.4 ha (5.97 % area))	SURVEYED BY	HEMRA CHETRI
DRAWING NO	ANNEXURE 6A01	DATE	JUNE 2012	DEBAGATED BY	BINISH PRADHAN
SCALE BAR					CHECKED BY K.S. CHALLY ADAPTED BY M.K. PRADHAN

SCALE	1 : 1000	LEASE AREA	(2.4 ha (5.97 % area))	SURVEYED BY	HEMRA CHETRI
DRAWING NO	ANNEXURE 6A01	DATE	JUNE 2012	DEBAGATED BY	BINISH PRADHAN
SCALE BAR					CHECKED BY K.S. CHALLY ADAPTED BY M.K. PRADHAN

SCALE	1 : 1000	LEASE AREA	(2.4 ha (5.97 % area))	SURVEYED BY	HEMRA CHETRI
DRAWING NO	ANNEXURE 6A01	DATE	JUNE 2012	DEBAGATED BY	BINISH PRADHAN
SCALE BAR					CHECKED BY K.S. CHALLIY ADAPTED BY M.K. PRADHAN

SCALE	1 : 1000	LEASE AREA	(2.4 ha (5.97 % area))	SURVEYED BY	HEMRA CHETRI
DRAWING NO	ANNEXURE 6A01	DATE	JUNE 2012	DEBAGATED BY	BINISH PRADHAN
SCALE BAR					CHECKED BY K.S. CHALLIY ADAPTED BY M.K. PRADHAN

SCALE	1 : 1000	LEASE AREA	(2.4 ha (5.97 % area))	SURVEYED BY	HEMRA CHETRI
DRAWING NO	ANNEXURE 6A01	DATE	JUNE 2012	DEBAGATED BY	BINISH PRADHAN
SCALE BAR					CHECKED BY K.S. CHALLY ADAPTED BY M.K. PRADHAN

SCALE	1 : 1000	LEASE AREA	(2.4 ha (5.97 % area))	SURVEYED BY	HEMRA CHETRI
DRAWING NO	ANNEXURE 6A01	DATE	JUNE 2012	DEBAGATED BY	BINISH PRADHAN
SCALE BAR					CHECKED BY K.S. CHALLY ADAPTED BY M.K. PRADHAN

VIEWING ANGLE 270 WITH DOWN DIP OF 41



VIEWING ANGLE 270 WITH DOWN DIP OF 36



PLAN VIEW



VIEWING ANGLE 270 WITH DOWN DIP OF 10

PROPOSED CRUSHING PLANT SITE

LEVELWISE EXTRACTION OF ROCK DURING THE YEAR

Year	From m (AMS)	To m (AMS)	Overburden Volume (m ³)	Rock Volume (Metc tonnes)	Rock Volume (Cubic Metres)	Cumulative Overburden Volume (m ³)	Cumulative Rock Volume (Metc tonnes)
1	2405	2440	1,714	-	-	1,714	-
	2400	2435	2,417	2,353	6,792	4,131	6,792
	2425	2430	2,235	4,973	13,178	6,366	19,969
	2420	2425	2,271	6,605	17,551	8,643	37,290



TOWARDS TRASHIANG

TOWARDS SAMBIR P. JONGKILAR



TENTATIVE PIT PLAN AT THE END OF FIRST YEAR
NANGSING STONE QUARRY, TSHELINGOR
ZOBEL GEWOG, PEMAGATSHEL DZONGKHAG

SCALE	1:100	DATE	15/06/2012	CHECKED BY	AKASH KANTHA
DRAWING NO.	100/2012	DATE	15/06/2012	APPROVED BY	

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25' = 1" 1:250
50' = 1" 1:500
100' = 1" 1:1000
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400' = 1" 1:4000
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VIEWING ANGLE 270 WITH DOWN DIP OF 44



VIEWING ANGLE 270 WITH DOWN DIP OF 35



PLAN VIEW



VIEWING ANGLE 200 WITH DOWN DIP OF 10



PROPOSED CRUSHING PLANT SITE

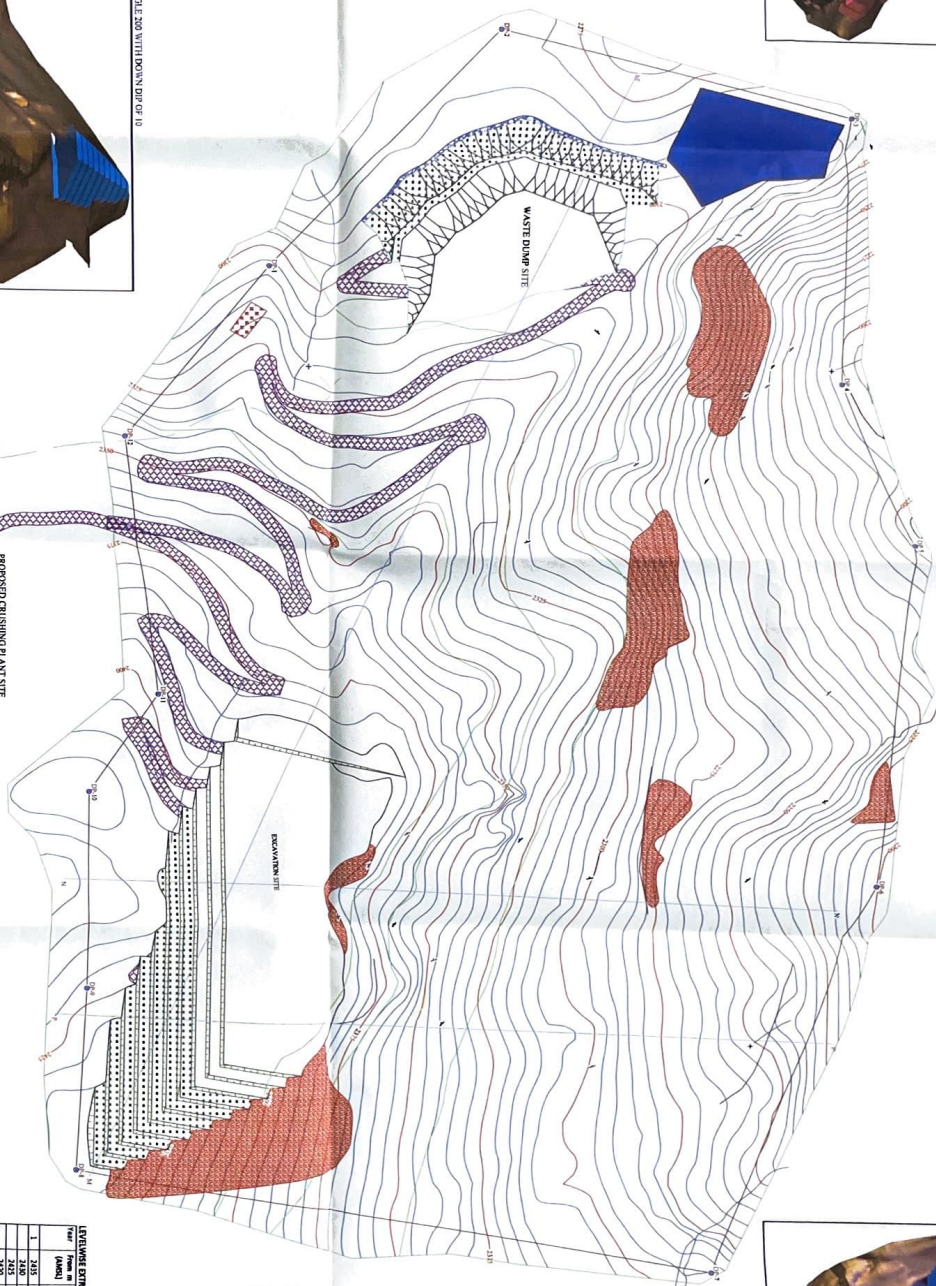
TOWARDS SANDIPONNOKIAK

TOWARDS TASHANAK

ESTIMATES EXTRACTION OF ROCK DURING THE YEAR									
Year	From 10 to 20 m	Overburden	Rock Volume	Rock Volume	Overburden	Overburden	Cumulative Rock	Cumulative Rock	
(MMS)	(MMS)	(MMS)	(M ³)	(M ³)	(M ³)	(M ³)	(M ³)	(M ³)	
1	2435	2435	1,114	2,563	6,291	4,131	6,291	4,131	24,500
2	2435	2435	2,212	4,775	12,582	8,262	12,582	8,262	24,500
3	2435	2435	2,233	4,971	13,176	8,595	13,176	8,595	24,500
4	2435	2435	2,277	5,248	13,753	8,930	13,753	8,930	24,500
5	2435	2435	2,321	5,525	14,329	9,265	14,329	9,265	24,500
6	2435	2435	2,365	5,802	14,906	9,600	14,906	9,600	24,500
7	2435	2435	2,409	6,079	15,482	9,935	15,482	9,935	24,500
8	2435	2435	2,453	6,356	16,059	10,270	16,059	10,270	24,500
9	2435	2435	2,497	6,633	16,635	10,605	16,635	10,605	24,500
10	2435	2435	2,541	6,910	17,212	10,940	17,212	10,940	24,500
11	2435	2435	2,585	7,187	17,788	11,275	17,788	11,275	24,500
12	2435	2435	2,629	7,464	18,365	11,610	18,365	11,610	24,500
13	2435	2435	2,673	7,741	18,941	11,945	18,941	11,945	24,500
14	2435	2435	2,717	8,018	19,518	12,280	19,518	12,280	24,500
15	2435	2435	2,761	8,295	20,094	12,615	20,094	12,615	24,500
16	2435	2435	2,805	8,572	20,671	12,950	20,671	12,950	24,500
17	2435	2435	2,849	8,849	21,247	13,285	21,247	13,285	24,500
18	2435	2435	2,893	9,126	21,824	13,620	21,824	13,620	24,500
19	2435	2435	2,937	9,403	22,400	13,955	22,400	13,955	24,500
20	2435	2435	2,981	9,680	22,977	14,290	22,977	14,290	24,500
21	2435	2435	3,025	9,957	23,553	14,625	23,553	14,625	24,500
22	2435	2435	3,069	10,234	24,130	14,960	24,130	14,960	24,500
23	2435	2435	3,113	10,511	24,706	15,295	24,706	15,295	24,500
24	2435	2435	3,157	10,788	25,283	15,630	25,283	15,630	24,500
25	2435	2435	3,201	11,065	25,859	15,965	25,859	15,965	24,500
26	2435	2435	3,245	11,342	26,436	16,300	26,436	16,300	24,500
27	2435	2435	3,289	11,619	27,012	16,635	27,012	16,635	24,500
28	2435	2435	3,333	11,896	27,589	16,970	27,589	16,970	24,500
29	2435	2435	3,377	12,173	28,165	17,305	28,165	17,305	24,500
30	2435	2435	3,421	12,450	28,742	17,640	28,742	17,640	24,500
31	2435	2435	3,465	12,727	29,318	17,975	29,318	17,975	24,500
32	2435	2435	3,509	13,004	29,895	18,310	29,895	18,310	24,500
33	2435	2435	3,553	13,281	30,471	18,645	30,471	18,645	24,500
34	2435	2435	3,597	13,558	31,048	18,980	31,048	18,980	24,500
35	2435	2435	3,641	13,835	31,624	19,315	31,624	19,315	24,500
36	2435	2435	3,685	14,112	32,201	19,650	32,201	19,650	24,500
37	2435	2435	3,729	14,389	32,777	19,985	32,777	19,985	24,500
38	2435	2435	3,773	14,666	33,354	20,320	33,354	20,320	24,500
39	2435	2435	3,817	14,943	33,930	20,655	33,930	20,655	24,500
40	2435	2435	3,861	15,220	34,507	20,990	34,507	20,990	24,500
41	2435	2435	3,905	15,497	35,083	21,325	35,083	21,325	24,500
42	2435	2435	3,949	15,774	35,660	21,660	35,660	21,660	24,500
43	2435	2435	3,993	16,051	36,236	21,995	36,236	21,995	24,500
44	2435	2435	4,037	16,328	36,813	22,330	36,813	22,330	24,500
45	2435	2435	4,081	16,605	37,389	22,665	37,389	22,665	24,500
46	2435	2435	4,125	16,882	37,966	23,000	37,966	23,000	24,500
47	2435	2435	4,169	17,159	38,542	23,335	38,542	23,335	24,500
48	2435	2435	4,213	17,436	39,119	23,670	39,119	23,670	24,500
49	2435	2435	4,257	17,713	39,695	24,005	39,695	24,005	24,500
50	2435	2435	4,301	17,990	40,272	24,340	40,272	24,340	24,500
51	2435	2435	4,345	18,267	40,848	24,675	40,848	24,675	24,500
52	2435	2435	4,389	18,544	41,425	25,010	41,425	25,010	24,500
53	2435	2435	4,433	18,821	41,999	25,345	41,999	25,345	24,500
54	2435	2435	4,477	19,098	42,576	25,680	42,576	25,680	24,500
55	2435	2435	4,521	19,375	43,152	26,015	43,152	26,015	24,500
56	2435	2435	4,565	19,652	43,729	26,350	43,729	26,350	24,500
57	2435	2435	4,609	19,929	44,305	26,685	44,305	26,685	24,500
58	2435	2435	4,653	20,206	44,882	27,020	44,882	27,020	24,500
59	2435	2435	4,697	20,483	45,458	27,355	45,458	27,355	24,500
60	2435	2435	4,741	20,760	46,035	27,690	46,035	27,690	24,500
61	2435	2435	4,785	21,037	46,611	28,025	46,611	28,025	24,500
62	2435	2435	4,829	21,314	47,188	28,360	47,188	28,360	24,500
63	2435	2435	4,873	21,591	47,764	28,695	47,764	28,695	24,500
64	2435	2435	4,917	21,868	48,341	29,030	48,341	29,030	24,500
65	2435	2435	4,961	22,145	48,917	29,365	48,917	29,365	24,500
66	2435	2435	5,005	22,422	49,494	29,700	49,494	29,700	24,500
67	2435	2435	5,049	22,699	50,070	30,035	50,070	30,035	24,500
68	2435	2435	5,093	22,976	50,647	30,370	50,647	30,370	24,500
69	2435	2435	5,137	23,253	51,223	30,705	51,223	30,705	24,500
70	2435	2435	5,181	23,530	51,800	31,040	51,800	31,040	24,500
71	2435	2435	5,225	23,807	52,376	31,375	52,376	31,375	24,500
72	2435	2435	5,269	24,084	52,953	31,710	52,953	31,710	24,500
73	2435	2435	5,313	24,361	53,529	32,045	53,529	32,045	24,500
74	2435	2435	5,357	24,638	54,106	32,380	54,106	32,380	24,500
75	2435	2435	5,401	24,915	54,682	32,715	54,682	32,715	24,500
76	2435	2435	5,445	25,192	55,259	33,050	55,259	33,050	24,500
77	2435	2435	5,489	25,469	55,835	33,385	55,835	33,385	24,500
78	2435	2435	5,533	25,746	56,412	33,720	56,412	33,720	24,500
79	2435	2435	5,577	26,023	56,988	34,055	56,988	34,055	24,500
80	2435	2435	5,621	26,300	57,565	34,390	57,565	34,390	24,500
81	2435	2435	5,665	26,577	58,141	34,725	58,141	34,725	24,500
82	2435	2435	5,709	26,854	58,718	35,060	58,718	35,060	24,500
83	2435	2435	5,753	27,131	59,294	35,395	59,294	35,395	24,500
84	2435	2435	5,797	27,408	59,871	35,730	59,871	35,730	24,500
85	2435	2435	5,841	27,685	60,447	36,065	60,447	36,065	24,500
86	2435	2435	5,885	27,962	61,024	36,400	61,024	36,400	24,500
87	2435	2435	5,929	28,239	61,600	36,735	61,600	36,735	24,500
88	2435	2435	5,973	28,516	62,177	37,070	62,177	37,070	24,500
89	2435	2435	6,017	28,793	62,753	37,405	62,753	37,405	24,500
90	2435	2435	6,061	29,070	63,330	37,740	63,330	37,740	24,500
91	2435	2435	6,105	29,347	63,906	38,075	63,906	38,075	24,500
92	2435	2435	6,149	29,624	64,483	38,410	64,483	38,410	24,500
93	2435	2435	6,193	29,901	65,059	38,745	65,059	38,745	24,500
94	2435	2435	6,237	30,178	65,636	39,080	65,636	39,080	24,500
95	2435	2435	6,281	30,455	66,212	39,415	66,212	39,415	24,500
96	2435	2435	6,325	30,732	66,789	39,750	66,789	39,750	24,500
97	2435	2435	6,369	31,009	67,365	40,085	67,365	40,085	24,500
98	2435	2435	6,413	31,286	67,942	40,420	67,942	40,420	24,500
99	2435	2435	6,457	31,563	68,518	40,755	68,518	40,755	24,500
100	2435	2435	6,501	31,840	69,095	41,090	69,095	41,090	24,500

NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED
TENTATIVE PIT PLAN AT THE END OF FOURTH YEAR
NGANGSING STONE QUARRY, TSHENINGOR
ZOBEL GEWOG, PEMAGATSHEL, DZONGKHAG

SCALE	1:1000	DRAWN BY	DATE	CHECKED BY	APPROVED BY
SCALE BAR	0 20 40 60 80 100				



STRENGTH EVALUATION OF POOL DURING THE YEAR					
	STRENGTH EVALUATION		STRENGTH EVALUATION		
	(Actual)	(Values)	(Actual)	(Values)	
1	2,015	2,060	3,741	3,786	1,724
2	2,015	2,060	3,741	3,786	1,724
3	2,015	2,060	3,741	3,786	1,724
4	2,015	2,060	3,741	3,786	1,724
5	2,015	2,060	3,741	3,786	1,724
6	2,015	2,060	3,741	3,786	1,724
7	2,015	2,060	3,741	3,786	1,724
8	2,015	2,060	3,741	3,786	1,724
9	2,015	2,060	3,741	3,786	1,724
10	2,015	2,060	3,741	3,786	1,724
11	2,015	2,060	3,741	3,786	1,724
12	2,015	2,060	3,741	3,786	1,724
13	2,015	2,060	3,741	3,786	1,724
14	2,015	2,060	3,741	3,786	1,724
15	2,015	2,060	3,741	3,786	1,724
16	2,015	2,060	3,741	3,786	1,724
17	2,015	2,060	3,741	3,786	1,724
18	2,015	2,060	3,741	3,786	1,724
19	2,015	2,060	3,741	3,786	1,724
20	2,015	2,060	3,741	3,786	1,724
21	2,015	2,060	3,741	3,786	1,724
22	2,015	2,060	3,741	3,786	1,724
23	2,015	2,060	3,741	3,786	1,724
24	2,015	2,060	3,741	3,786	1,724
25	2,015	2,060	3,741	3,786	1,724
26	2,015	2,060	3,741	3,786	1,724
27	2,015	2,060	3,741	3,786	1,724
28	2,015	2,060	3,741	3,786	1,724
29	2,015	2,060	3,741	3,786	1,724
30	2,015	2,060	3,741	3,786	1,724
31	2,015	2,060	3,741	3,786	1,724
32	2,015	2,060	3,741	3,786	1,724
33	2,015	2,060	3,741	3,786	1,724
34	2,015	2,060	3,741	3,786	1,724
35	2,015	2,060	3,741	3,786	1,724
36	2,015	2,060	3,741	3,786	1,724
37	2,015	2,060	3,741	3,786	1,724
38	2,015	2,060	3,741	3,786	1,724
39	2,015	2,060	3,741	3,786	1,724
40	2,015	2,060	3,741	3,786	1,724
41	2,015	2,060	3,741	3,786	1,724
42	2,015	2,060	3,741	3,786	1,724
43	2,015	2,060	3,741	3,786	1,724
44	2,015	2,060	3,741	3,786	1,724
45	2,015	2,060	3,741	3,786	1,724
46	2,015	2,060	3,741	3,786	1,724
47	2,015	2,060	3,741	3,786	1,724
48	2,015	2,060	3,741	3,786	1,724
49	2,015	2,060	3,741	3,786	1,724
50	2,015	2,060	3,741	3,786	1,724
51	2,015	2,060	3,741	3,786	1,724
52	2,015	2,060	3,741	3,786	1,724
53	2,015	2,060	3,741	3,786	1,724
54	2,015	2,060	3,741	3,786	1,724
55	2,015	2,060	3,741	3,786	1,724
56	2,015	2,060	3,741	3,786	1,724
57	2,015	2,060	3,741	3,786	1,724
58	2,015	2,060	3,741	3,786	1,724
59	2,015	2,060	3,741	3,786	1,724
60	2,015	2,060	3,741	3,786	1,724
61	2,015	2,060	3,741	3,786	1,724
62	2,015	2,060	3,741	3,786	1,724
63	2,015	2,060	3,741	3,786	1,724
64	2,015	2,060	3,741	3,786	1,724
65	2,015	2,060	3,741	3,786	1,724
66	2,015	2,060	3,741	3,786	1,724
67	2,015	2,060	3,741	3,786	1,724
68	2,015	2,060	3,741	3,786	1,724
69	2,015	2,060	3,741	3,786	1,724
70	2,015	2,060	3,741	3,786	1,724
71	2,015	2,060	3,741	3,786	1,724
72	2,015	2,060	3,741	3,786	1,724
73	2,015	2,060	3,741	3,786	1,724
74	2,015	2,060	3,741	3,786	1,724
75	2,015	2,060	3,741	3,786	1,724
76	2,015	2,060	3,741	3,786	1,724
77	2,015	2,060	3,741	3,786	1,724
78	2,015	2,060	3,741	3,786	1,724
79	2,015	2,060	3,741	3,786	1,724
80	2,015	2,060	3,741	3,786	1,724
81	2,015	2,060	3,741	3,786	1,724
82	2,015	2,060	3,741	3,786	1,724
83	2,015	2,060	3,741	3,786	1,724
84	2,015	2,060	3,741	3,786	1,724
85	2,015	2,060	3,741	3,786	1,724
86	2,015	2,060	3,741	3,786	1,724
87	2,015	2,060	3,741	3,786	1,724
88	2,015	2,060	3,741	3,786	1,724
89	2,015	2,060	3,741	3,786	1,724
90	2,015	2,060	3,741	3,786	1,724
91	2,015	2,060	3,741	3,786	1,724
92	2,015	2,060	3,741	3,786	1,724
93	2,015	2,060	3,741	3,786	1,724
94	2,015	2,060	3,741	3,786	1,724
95	2,015	2,060	3,741	3,786	1,724
96	2,015	2,060	3,741	3,786	1,724
97	2,015	2,060	3,741	3,786	1,724
98	2,015	2,060	3,741	3,786	1,724
99	2,015	2,060	3,741	3,786	1,724
100	2,015	2,060	3,741	3,786	1,724



NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED

TENTATIVE PIT PLAN AT THE END OF FIFTH YEAR

ZOBEL, GEVOG, PEMAGATSHEL DZONGKHLAG

ZOBEL GEWOG, PEMAGATSHEL DZONGKHLAG

SCALE	1:1000	DATE REC'D	12-18-2012
DRAWING NO.	ANNEVILLE (APV)	DATE	JUNE 2012
SCALE BAR			
DRAWN BY	M. J. BUCHANAN		
CHECKED BY			
APPROVED BY			

Annexure 6.7
(A TO M)

Cross-Sections





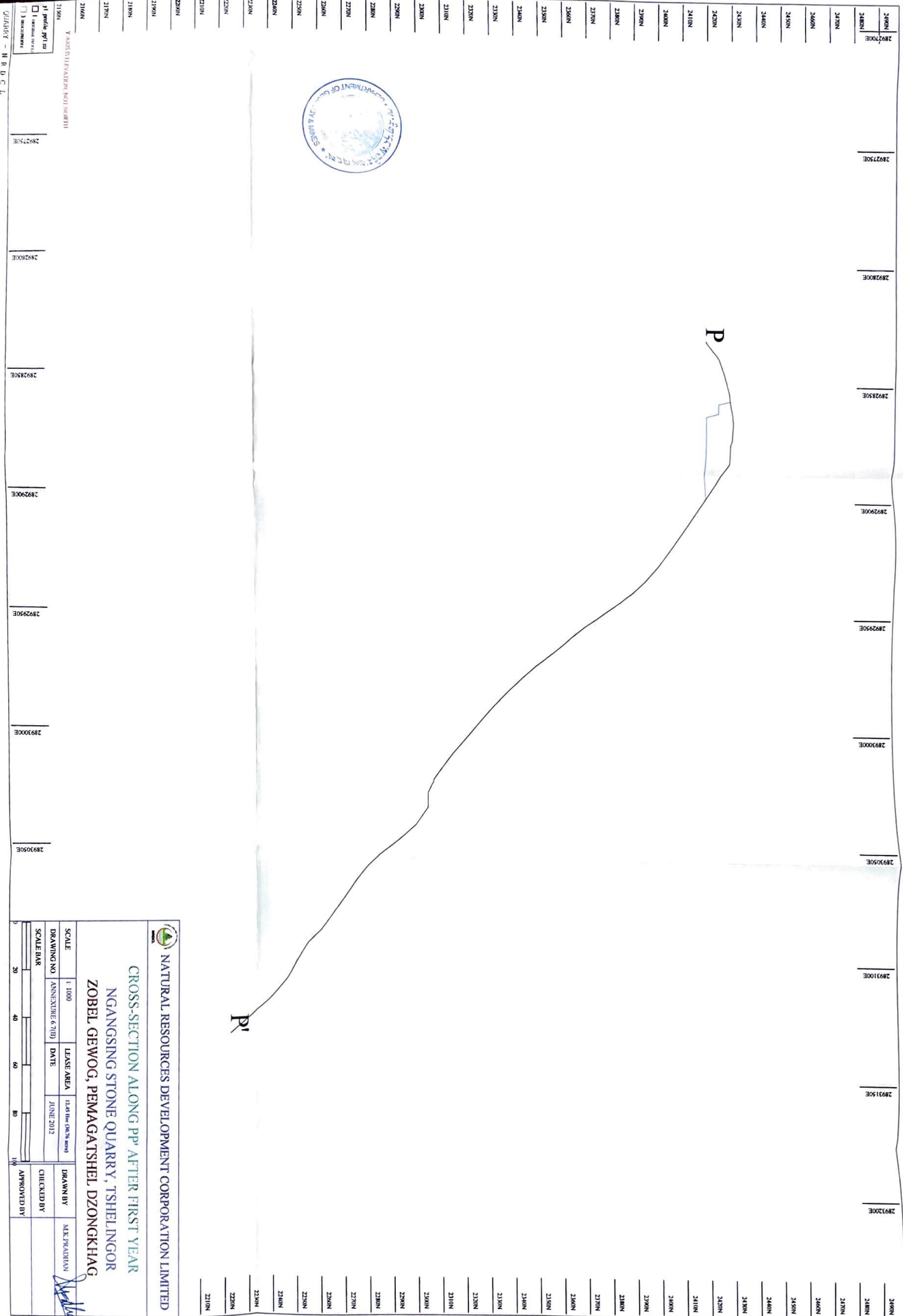
M'

M

BENCH PROFILE

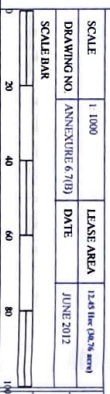
WASTE DUMP PROFILE

NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED			
CROSS-SECTION ALONG MM' AFTER FIRST YEAR			
NGANGSING STONE QUARRY, TSHELINGOR			
ZOBEL GEWOG, PEMAGATSHIEL DZONGKHAG			
SCALE	1:1000	LEASE AREA	12.43 Hect (30.76 Acre)
DRAWING NO.	ANNEXURE 6(TA)	DATE	JUNE 2012
SCALE BAR	0 20 40 60 80 100		DRAWN BY
			MC. MOCHIN
			CHECKED BY
			APPROVED BY

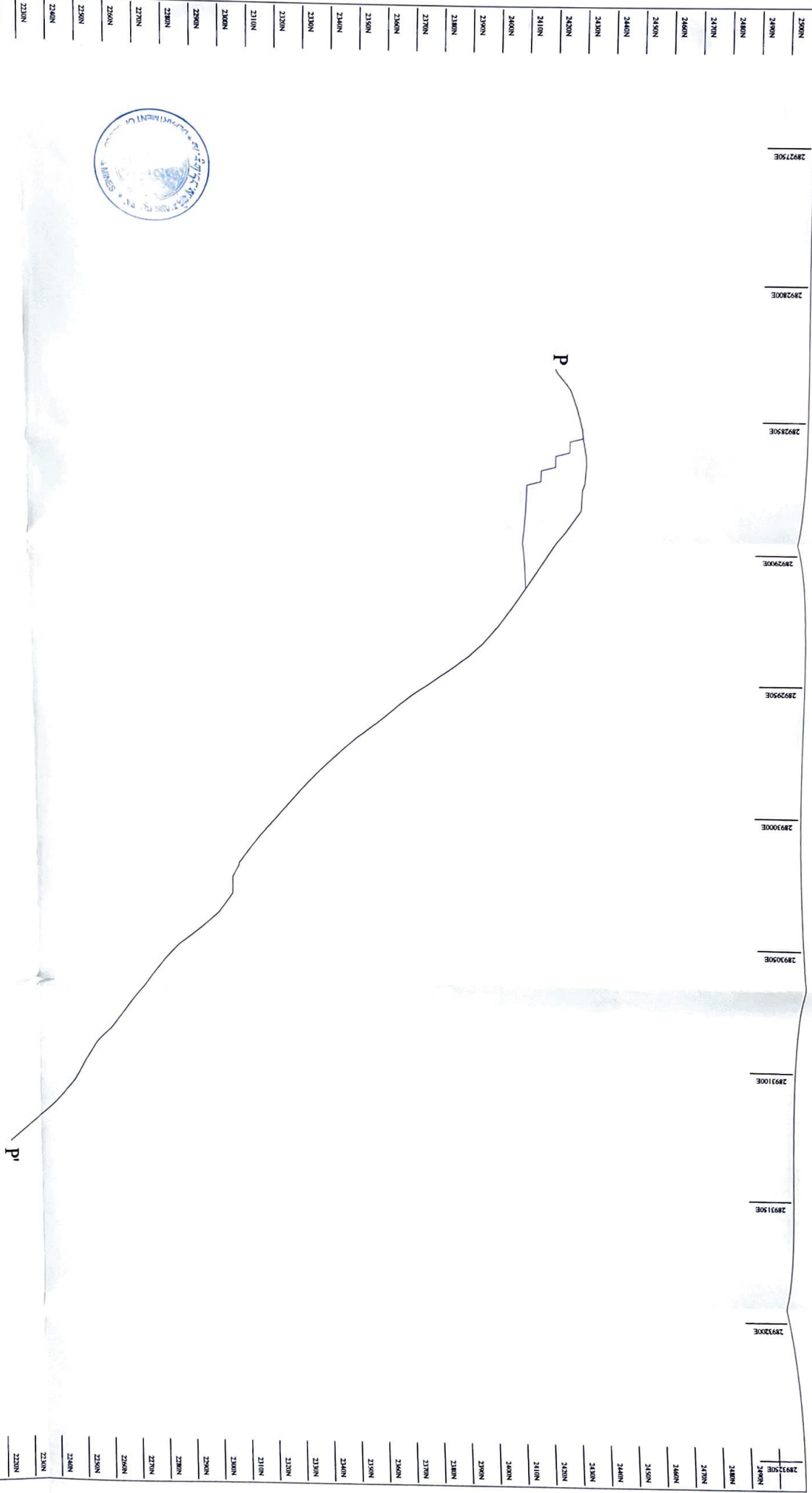


 NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED

CROSS-SECTION ALONG PP' AFTER FIRST YEAR
NGANGSING STONE QUARRY, TSHELINGOR
ZOBEL GEWOG, PEMAGATSHEL, DZONGKHAG

SCALE	1:1000	LEASE AREA	12.45 Hec (30.75 acre)	DRAWN BY	N.K. PRADHAN
DRAWING NO	ANNEXURE 6 (10)	DATE	JUNE 2012	CHECKED BY	
SCALE BAR				APPROVED BY	

1:1000
V. ANSUTHEVARAJAN (M2) INCH/FT
1/1 profile ppt in
1/1 aerial photo
3/1 sketch map

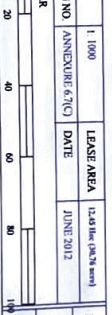


P'

P

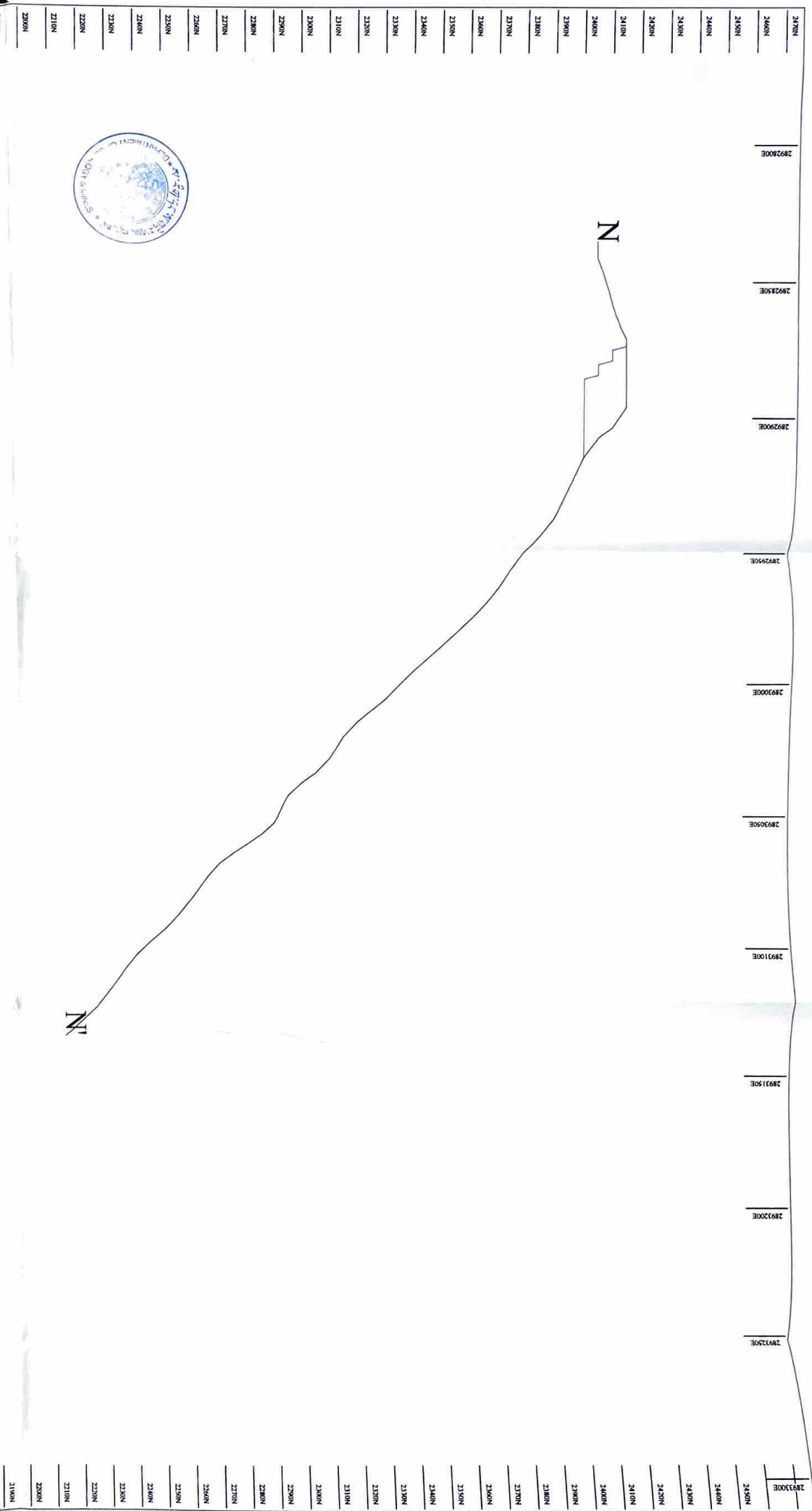
 **NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED**

CROSS-SECTION ALONG P-P' AFTER SECOND YEAR
NGANGSING STONE QUARRY, TSHELINGOR
ZOBEL GEWOG, PEMAGATSHHEL DZONGKHAG

SCALE	1:1000	LEASE AREA	15.42 Hec (37.8 acre)	DRAWN BY	M.K. PRADHON
DRAWING NO	ANNEXURE 6/7C	DATE	JUNE 2012	CHECKED BY	
SCALE BAR				APPROVED BY	

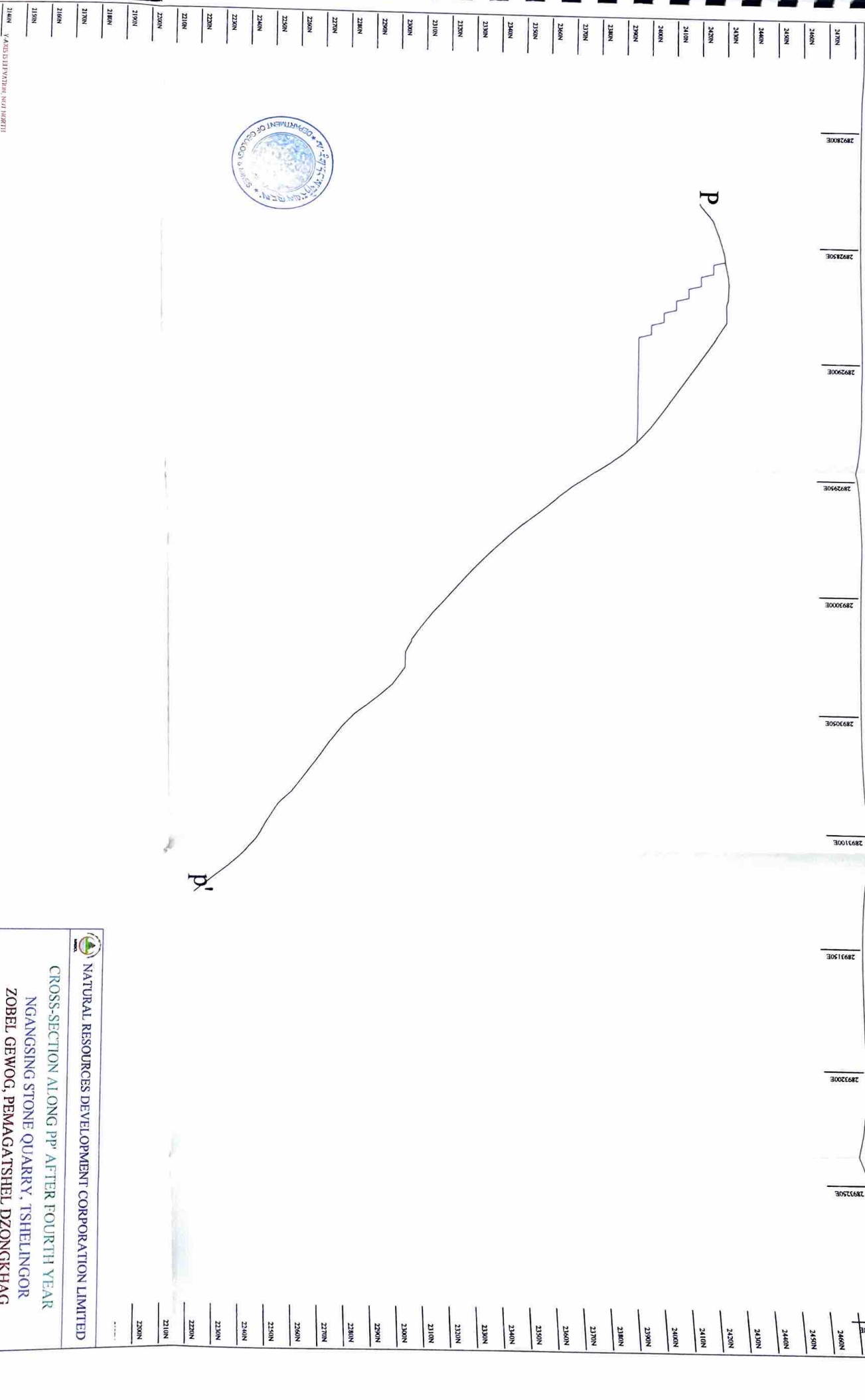
1:1000
N-4325 IS ELEVATION, NOT NORTH
☐ 1 printed map
☐ 2 printed map

QUARRY - N R D C L



NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED			
CROSS-SECTION ALONG NN' AFTER THIRD YEAR			
NGANGSING STONE QUARRY, TSHELINGOR			
ZOBEL GEWOG, PEMAGATSHEL DZONGKHAG			
SCALE	1:1000	LEASE AREA	12.40 Hec (30.76 acre)
DRAWING NO.	ANNEXURE 6 T/D	DATE	JUNE 2012
SCALE BAR		DRAWN BY	M.N. PRADHAN
0 20 40 60 80 100		CHECKED BY	
		APPROVED BY	

QUARRY - N R D C. L.



2140N 2150N 2160N 2170N 2180N 2190N 2200N 2210N 2220N 2230N 2240N 2250N 2260N 2270N 2280N 2290N 2300N 2310N 2320N 2330N 2340N 2350N 2360N 2370N 2380N 2390N 2400N 2410N 2420N 2430N 2440N 2450N 2460N 2470N

289100E 289150E 289200E 289250E 289300E 289350E

NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED

CROSS-SECTION ALONG PP' AFTER FOURTH YEAR

NGANGSING STONE QUARRY, TSHELINGOR

ZOBEL GEWOG, PEMAGATSHEL DZONGKHAG

SCALE	1:1000	LEASE AREA	12.47 Hec (30.53 acre)
DRAWING NO.	ANNEXURE 6 (70)	DATE	JUNE 2012
SCALE BAR	<div><div></div><div>0</div><div>20</div><div>40</div><div>60</div><div>80</div><div>100</div></div>		
DRAWN BY	M.K. PRADHAN		
CHECKED BY			
APPROVED BY			


4. make pdf in
☐ save as pdf
☐ save as image

Utility - H R O C L



Pi

P

			
NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED			
CROSS-SECTION ALONG P-P' AFTER THIRD YEAR			
NGANGSING STONE QUARRY, TSHELINGOR			
ZOBEL GEWOG, PEMAGATSHEL DZONGKHAG			
SCALE	1 : 1000	LEASE AREA	12.43 Hec (30.75 acre)
DRAWING NO.	ANNEXURE 6 (NE)	DATE	JUNE 2012
SCALE BAR		DRAWN BY	M.L. PRADHAN
0 20 40 60 80 100		CHECKED BY	
		APPROVED BY	

2470N	2892800E	2470N	2893300E
2460N	2892850E	2460N	2893300E
2450N	2892900E	2450N	2893300E
2440N	2892950E	2440N	2893300E
2430N	2893000E	2430N	2893300E
2420N	2893050E	2420N	2893300E
2410N	2893100E	2410N	2893300E
2400N	2893150E	2400N	2893300E
2390N	2893200E	2390N	2893300E
2380N	2893250E	2380N	2893300E
2370N	2893300E	2370N	2893300E
2360N	2893350E	2360N	2893300E
2350N	2893400E	2350N	2893300E
2340N	2893450E	2340N	2893300E
2330N	2893500E	2330N	2893300E
2320N	2893550E	2320N	2893300E
2310N	2893600E	2310N	2893300E
2300N	2893650E	2300N	2893300E
2290N	2893700E	2290N	2893300E
2280N	2893750E	2280N	2893300E
2270N	2893800E	2270N	2893300E
2260N	2893850E	2260N	2893300E
2250N	2893900E	2250N	2893300E
2240N	2893950E	2240N	2893300E
2230N	2894000E	2230N	2893300E
2220N	2894050E	2220N	2893300E
2210N	2894100E	2210N	2893300E
2200N	2894150E	2200N	2893300E
2190N	2894200E	2190N	2893300E
2180N	2894250E	2180N	2893300E
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2160N	2894350E	2160N	2893300E
2150N	2894400E	2150N	2893300E
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1960N	2895350E	1960N	2893300E
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1940N	2895450E	1940N	2893300E
1930N	2895500E	1930N	2893300E
1920N	2895550E	1920N	2893300E
1910N	2895600E	1910N	2893300E
1900N	2895650E	1900N	2893300E
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1090N	2899700E	1090N	2893300E
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1060N	2899850E	1060N	2893300E
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420N	2903050E	420N	2893300E
410N	2903100E	410N	2893300E
400N	2903150E	400N	2893300E
390N	2903200E	390N	2893300E
380N	2903250E	380N	2893300E
370N	2903300E	370N	2893300E
360N	2903350E	360N	2893300E
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170N	2904300E	170N	2893300E
160N	2904350E	160N	2893300E
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140N	2904450E	140N	2893300E
130N	2904500E	130N	2893300E
120N	2904550E	120N	2893300E
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70N	2904800E	70N	2893300E
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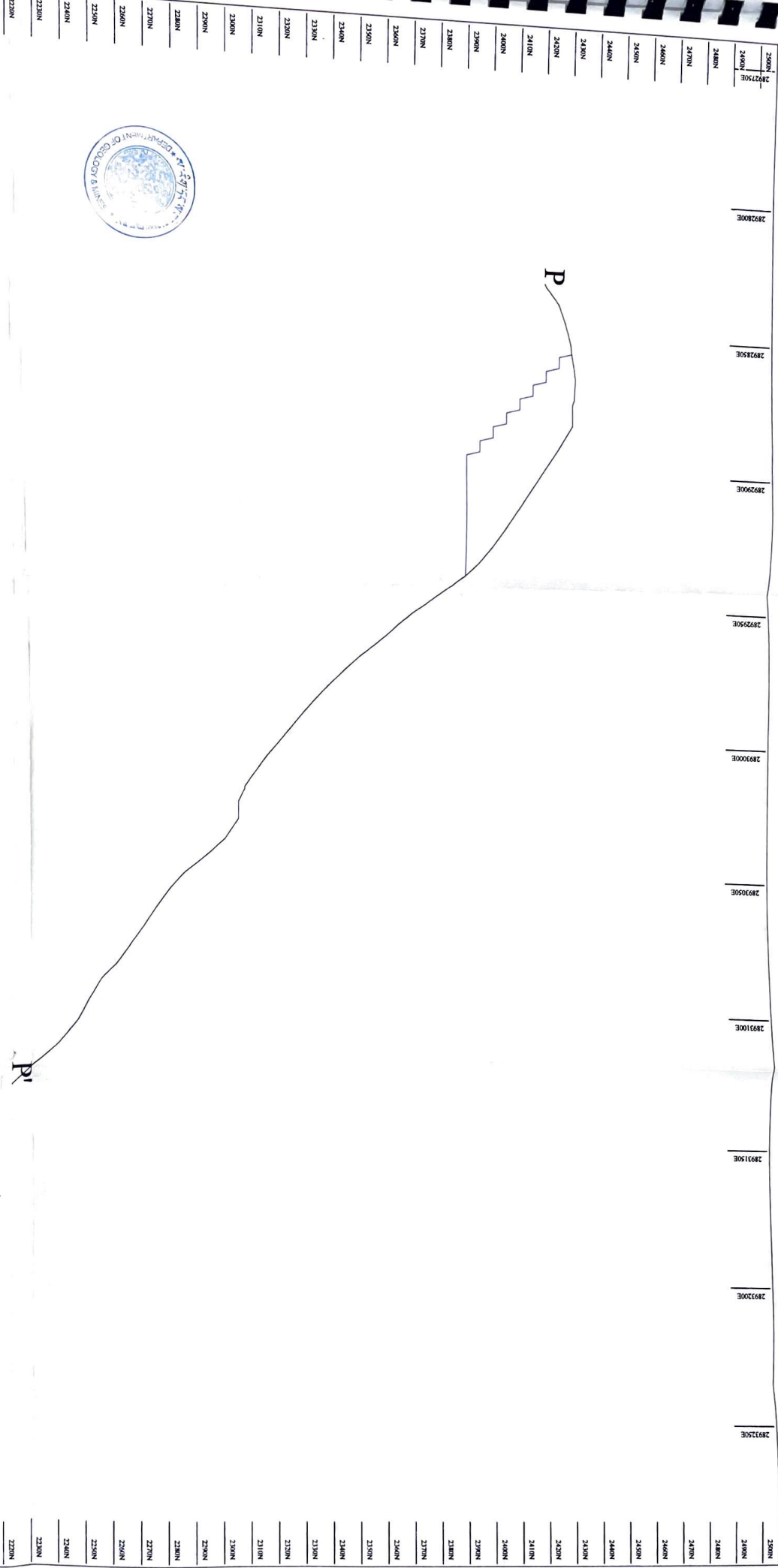
V-ANDB ELEVATION, NOT NORTH

☐ profile plot up

☐ 1 vertical scale

☐ 2 horizontal scale

UNITARY - N R D C L



NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED

CROSS-SECTION ALONG PP' AFTER FIFTH YEAR

NGANGSING STONE QUARRY, TSHELINGOR

ZOBEL GEWOG, PEMAGATSHEL DZONGKHAG

SCALE 1:1000

DRAWING NO. ANNEXURE 6/7D

LEASE AREA 12.40 Hec (30.76 acre)

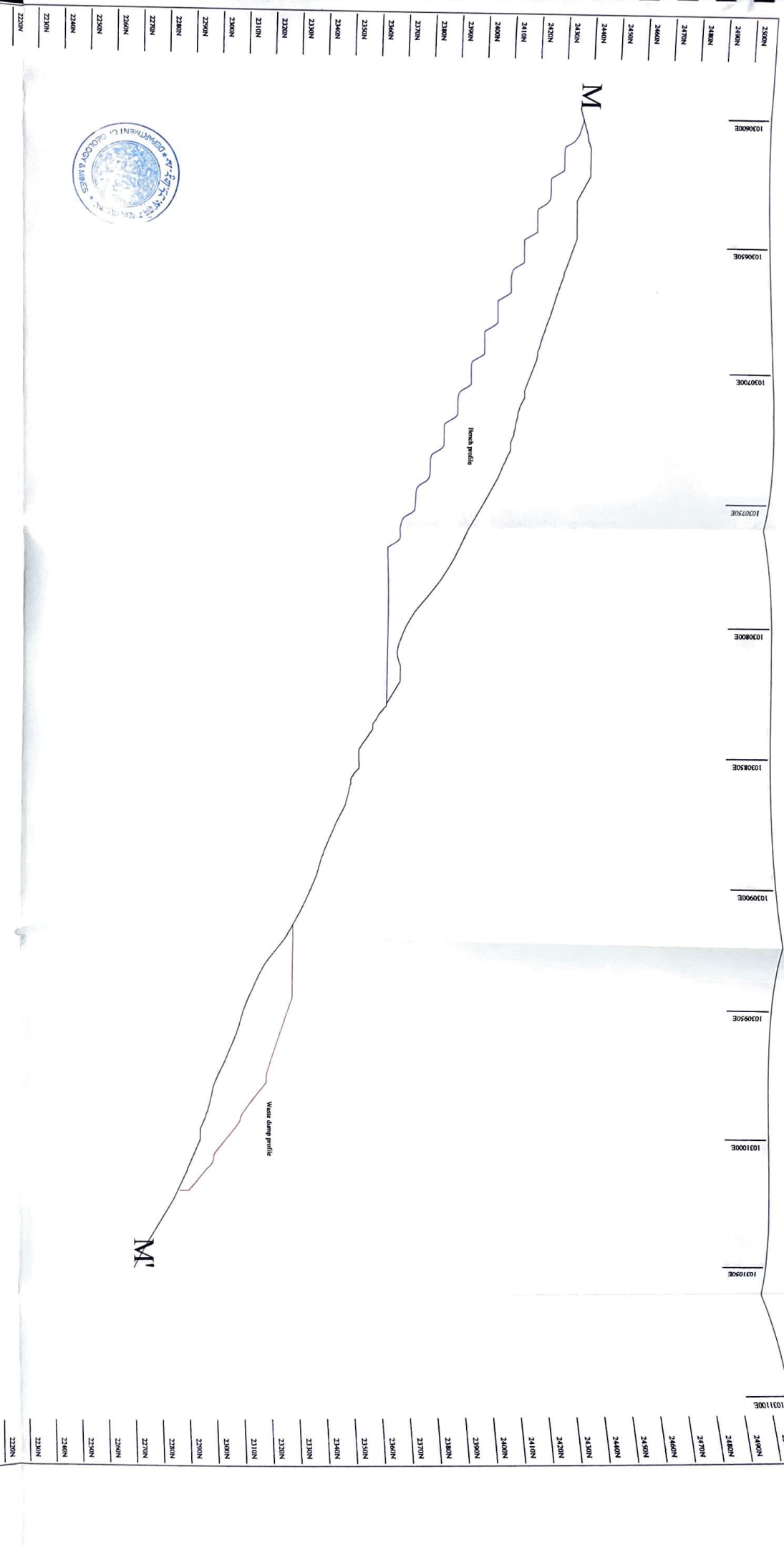
DATE JUNE 2012

SCALE BAR 0 20 40 60 80 100

DRAWN BY M.K. PRADHAN

CHECKED BY

APPROVED BY



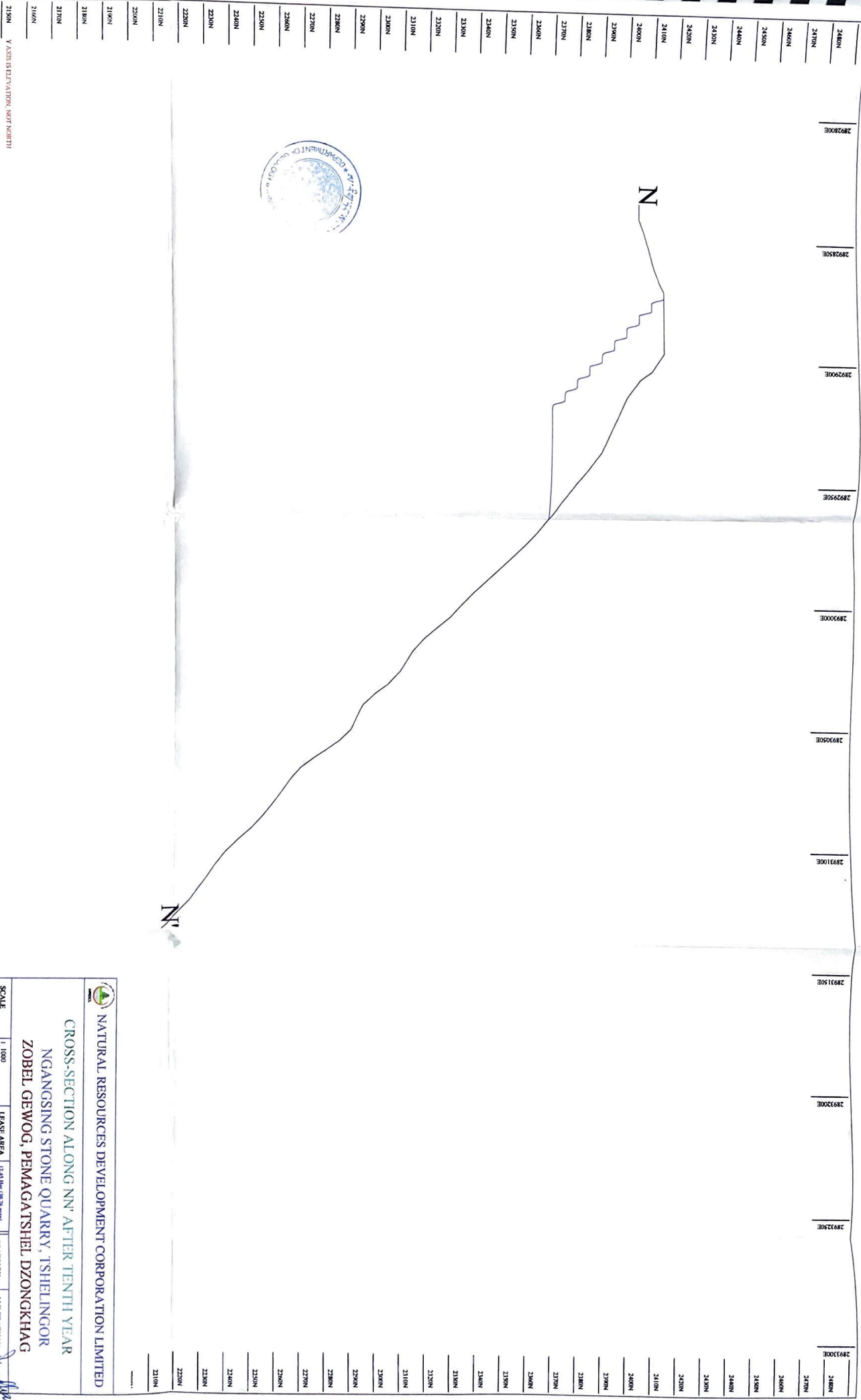
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1170N 1180N 1190N 1200N 1210N 1220N 1230N 1240N 1250N 1260N 1270N 1280N 1290N 1300N 1310N 1320N 1330N 1340N 1350N 1360N 1370N 1380N 1390N 1400N 1410N 1420N 1430N 1440N 1450N 1460N 1470N 1480N 1490N 1500N 1510N 1520N 1530N 1540N 1550N 1560N 1570N 1580N 1590N 1600N 1610N 1620N 1630N 1640N 1650N 1660N 1670N 1680N 1690N 1700N 1710N 1720N 1730N 1740N 1750N 1760N 1770N 1780N 1790N 1800N 1810N 1820N 1830N 1840N 1850N 1860N 1870N 1880N 1890N 1900N 1910N 1920N 1930N 1940N 1950N 1960N 1970N 1980N 1990N 2000N 2010N 2020N 2030N 2040N 2050N 2060N 2070N 2080N 2090N 2100N 2110N 2120N 2130N 2140N 2150N 2160N 2170N 2180N 2190N 2200N 2210N 2220N 2230N 2240N 2250N 2260N 2270N 2280N 2290N 2300N 2310N 2320N 2330N 2340N 2350N 2360N 2370N 2380N 2390N 2400N 2410N 2420N 2430N 2440N 2450N 2460N 2470N 2480N 2490N 2500N

CROSS-SECTION ALONG MM' AFTER TENTH YEAR
NGANGSING STONE QUARRY, TSHELINGGOR
ZOBEL GEWOG, PEMAGATSHEL DZONGKHAG

SCALE	1:1000	LEASE AREA	12.48 Hec (30.76 acre)	DRAWN BY	M.K. PRACHIN
DRAWING NO.	ANNEXURE 6.7(K)	DATE	JUNE 2012	CHECKED BY	
SCALE BAR					APPROVED BY

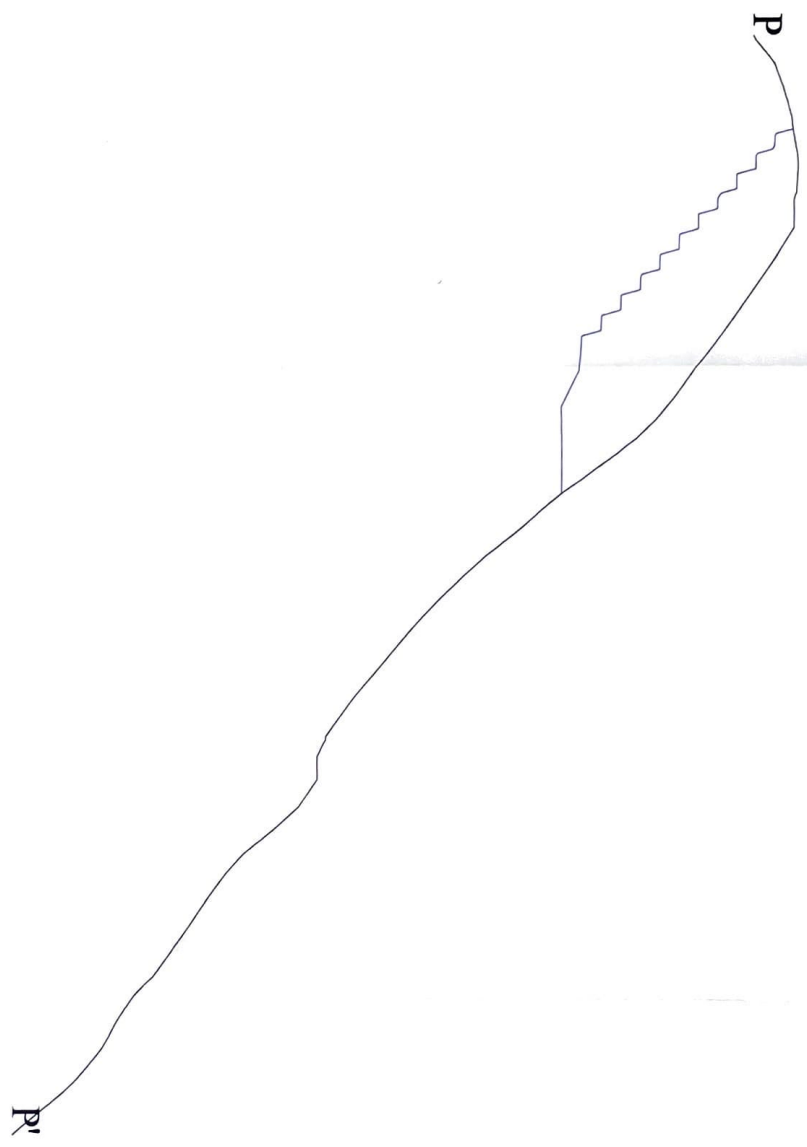
QUARRY - H R D C L





NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED			
CROSS-SECTION ALONG NN' AFTER TENTH YEAR			
NGANGSING STONE QUARRY, TSHELINGOR			
ZOBEL GEWOG, PEMAGATSHEL, DZONGKHAG			
SCALE	1:1000	LEASE AREA	12.45 Hec (30.78 acrs)
DRAWING NO	ANNEXURE 6.7(I)	DATE	JUNE 2012
SCALE BAR	0 20 40 60 80 100		
DRAWN BY		M.K. PRADHAN	
CHECKED BY			
APPROVED BY			

QUARRY - N R D C L

2470N	2470E
2460N	2460E
2450N	2450E
2440N	2440E
2430N	2430E
2420N	2420E
2410N	2410E
2400N	2400E
2390N	2390E
2380N	2380E
2370N	2370E
2360N	2360E
2350N	2350E
2340N	2340E
2330N	2330E
2320N	2320E
2310N	2310E
2300N	2300E
2290N	2290E
2280N	2280E
2270N	2270E
2260N	2260E
2250N	2250E
2240N	2240E
2230N	2230E
2220N	2220E
2210N	2210E
2200N	2200E
2190N	2190E
2180N	2180E
2170N	2170E
2160N	2160E
2150N	2150E
2140N	2140E



			
NATURAL RESOURCES DEVELOPMENT CORPORATION LIMITED			
CROSS-SECTION ALONG PP' AFTER TENTH YEAR			
NGANGSING STONE QUARRY, TSHELINGOR			
ZOBEL GEWOG, PEMAGATSHEL DZONGKHAG			
SCALE	1:1000	LEASE AREA	11.43 Hec (0.07 sq mi)
DRAWING NO.	ANNEXURE 6.7(N)	DATE	JUNE 2012
SCALE BAR			
DRAWN BY		CHECKED BY	
M.K. PRADHAN			
APPROVED BY			

<input type="checkbox"/> 10 profile ppt in
<input type="checkbox"/> 10 original maps
<input type="checkbox"/> 10 maps in folder

2892750E	2892850E	2892950E	2893000E	2893050E	2893100E	2893150E	2893200E	2893250E
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ANNEXURE 11.1: DEPRECIATION & AMORTISATION STATEMENT

FIXED ASSETS	TOTAL VALUE	DEPRECIATION & AMORTISATION RATE %	DEPRECIATION AMOUNT (Ru) in different years										Salvage value
			2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	
Preliminary expenses	532,000	10.00%	53,200	53,200	53,200	53,200	53,200	53,200	53,200	53,200	53,200	53,200	
Mine development	739,000	20.00%	147,800	147,800	147,800	147,800	147,800	0	0	0	0	0	
Approach road	1,089,000	20.00%	217,800	217,800	217,800	217,800	217,800	0	0	0	0	0	
Infrastructure	775,000	20.00%	155,000	155,000	155,000	155,000	155,000	0	0	0	0	0	
Excavator	6,600,000	15.00%	990,000	990,000	990,000	990,000	990,000	1,138,500	1,138,500	1,138,500	1,138,500	1,138,500	3,036,000
Compressor + drill	5,500,000	15.00%	825,000	825,000	825,000	825,000	825,000	948,750	948,750	948,750	948,750	948,750	2,530,000
Tipper	2,800,000	15.00%	420,000	420,000	420,000	420,000	420,000	483,000	483,000	483,000	483,000	483,000	1,288,000
Vehicles	2,150,000	15.00%	322,500	322,500	322,500	322,500	322,500	370,875	370,875	370,875	370,875	370,875	989,000
Water supply	450,000	10.00%	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	0
Fuel tank	150,000	15.00%	22,500	22,500	22,500	22,500	22,500	25,875	25,875	25,875	25,875	25,875	69,000
Magazine	500,000	10.00%	22,500	22,500	22,500	22,500	22,500	22,500	22,500	22,500	22,500	22,500	0
Other ancillary equipments	400,000	10.00%	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	0
TOTAL	21,685,000		3,261,300	3,261,300	3,261,300	3,261,300	3,261,300	2,740,700	3,127,700	3,127,700	3,127,700	3,127,700	7,912,000



ANNEXURE 11.2: COST OF QUARRY ROCK PRODUCTION

Product size	Quantity	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Average yearly cost (Nu.)	% cost per unit
Salary & wages		4,443,600	4,576,908	4,714,215	4,855,642	5,001,311	5,151,350	5,305,891	5,465,068	5,629,020	5,797,890	5,094,089	24.61%
Fuel and spares		3,287,418	6,213,220	7,248,757	7,611,194	7,991,754	8,391,342	8,810,909	9,251,454	9,714,027	10,199,728	7,871,980	38.03%
Explosive		515,832	956,352	1,094,492	1,127,327	1,161,147	1,195,981	1,231,860	1,268,816	1,306,881	1,346,087	1,120,478	5.41%
Repair & maintenance		295,000	531,000	590,000	619,500	650,475	682,999	717,149	753,006	790,656	830,189	645,997	3.12%
Administrative expenses		250,000	450,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	470,000	2.27%
Mineral Levy		122,814	205,314	236,251	236,251	236,251	247,080	247,080	247,080	258,449	258,449	229,502	1.11%
Environment Management		375,000	675,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	705,000	3.41%
Environment Restoration fund		0	500,000	500,000	500,000	500,000	500,000	0	0	0	0	250,000	1.21%
Depreciation		3,261,300	3,261,300	3,261,300	3,261,300	3,261,300	2,740,700	3,127,700	3,127,700	3,127,700	3,127,700	3,155,800	15.25%
Interest on long term loan	12%	1,502,771	1,346,639	1,190,507	1,034,375	878,243	722,111	565,979	409,847	253,715	97,583	800,177	3.87%
Interest on W.C loan	13%	3,554,724	0	0	0	0	0	0	0	0	0	355,472	1.72%
Sub-Total of expenses		17,608,458	18,715,733	20,085,522	20,495,589	20,930,481	20,881,562	21,256,567	21,772,970	22,330,447	22,907,627	20,698,495	
Cost per cubic feet, Nu.		18.78	11.09	10.71	10.93	11.16	11.14	11.34	11.61	11.91	12.22	11.74	
Cost per metric tonne, Nu.		470	277	268	273	279	278	283	290	298	305	293.60	



ANNEXURE 12.1: PROFITABILITY STATEMENT

Return from Sales

Product size	Quantity	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
All	75,000	11,250,000	20,250,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000
Total of sales	75,000	11,250,000	20,250,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000
Capacity utilisation		50%	90%	100%	100%	100%	100%	100%	100%	100%	100%
Total yearly quantity		37500	67500	75000	75000	75000	75000	75000	75000	75000	75000
Expenditure											
Salary & wages		4,443,600	4,576,908	4,714,215	4,855,642	5,001,311	5,151,350	5,305,891	5,465,068	5,629,020	5,797,890
Fuel and spares		3,287,418	6,213,220	7,248,757	7,611,194	7,991,754	8,391,342	8,810,909	9,251,454	9,714,027	10,199,728
Explosive		515,832	956,352	1,094,492	1,127,327	1,161,147	1,195,981	1,231,860	1,268,816	1,306,881	1,346,087
Repair & maintenance		295,000	531,000	590,000	619,500	650,475	682,999	717,149	753,006	790,656	830,189
Administrative expenses		250,000	450,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000
Mineral Levy		122,814	205,314	236,251	236,251	236,251	247,080	247,080	247,080	258,449	258,449
Environment Management		375,000	675,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000
Environment Restoration fund		0	500,000	500,000	500,000	500,000	500,000	0	0	0	0
Depreciation		3,261,300	3,261,300	3,261,300	3,261,300	3,261,300	2,740,700	3,127,700	3,127,700	3,127,700	3,127,700
Interest on long term loan	12%	1,502,771	1,346,639	1,190,507	1,034,375	878,243	722,111	565,979	409,847	253,715	97,583
Interest on W.C loan	13%	3,554,724	0	0	0	0	0	0	0	0	0
Sub-Total of expenses		17,608,458	18,715,733	20,085,522	20,495,589	20,930,481	20,881,562	21,256,567	21,772,970	22,330,447	22,907,627



Gross Profit		-6,358,458	1,534,267	2,414,478	2,004,411	1,569,519	1,618,438	1,243,433	727,030	169,553	-407,627
Provision for tax	30%	0	0	0	0	349,265	485,531	373,030	218,109	50,866	0
Net profit after tax		-6,358,458	1,534,267	2,414,478	2,004,411	1,220,254	1,132,907	870,403	508,921	118,687	-407,627

ANNEXURE 12.2: CASHFLOW STATEMENT (Figures in Ngultrums)

Outflow

Particulars/Year	0	1	2	3	4	5	6	7	8	9	10
Machinery & Structure	21,685,000	0	0	0	0	0	0	0	0	0	0
Interest on long term loan	0	1,502,771	1,346,639	1,190,507	1,034,375	878,243	722,111	565,979	409,847	253,715	97,583
Interest on W.C loan	0	3,554,724	0	0	0	0	0	0	0	0	0
Loan repayment	0	3,730,296	1,301,100	1,301,100	1,301,100	1,301,100	1,301,100	1,301,100	1,301,100	1,301,100	1,301,100
Production cost	0	9,289,664	14,107,794	15,633,715	16,199,914	16,790,938	17,418,751	17,562,888	18,235,424	18,949,033	19,682,344
Provision for tax	0	0	0	0	0	349,265	485,531	373,030	218,109	50,866	0
Working capital	3,238,928	0	0	0	0	0	0	0	0	0	0
Total outflow	24,923,928	18,077,454	16,755,533	18,125,322	18,535,389	19,319,546	19,927,493	19,802,997	20,164,479	20,554,713	21,081,027

Inflow

Sales return	0	11,250,000	20,250,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000	22,500,000
Sale of assets	0	0	0	0	0	0	0	0	0	0	0
Loan	13,011,000	0	0	0	0	0	1,585,000	0	0	0	7,912,000
Equity capital	8,674,000	0	0	0	0	0	0	0	0	0	0
Depreciation	0	3,261,300	3,261,300	3,261,300	3,261,300	3,261,300	2,740,700	3,127,700	3,127,700	3,127,700	3,127,700
Total inflow	21,685,000	14,511,300	23,511,300	25,761,300	25,761,300	26,825,700	25,627,700	25,627,700	25,627,700	33,539,700	33,539,700
Net cash flow	-24,923,928	-3,566,154	6,755,767	7,635,978	7,225,911	6,441,754	6,898,207	5,824,703	5,463,221	5,072,987	12,458,673

ANNEXURE12.3: LOAN REPAYMENT SCHEDULE (in Ngultrum)

Term Loan 13,011,000 Total 21,685,000
Equity 8,674,000

Quarter	Principal Year start	Interest	Repayment	Principal Year end
1	13,011,000	390,330	325,275	12,685,725
2	12,685,725	380,572	325,275	12,360,450
3	12,360,450	370,814	325,275	12,035,175
4	12,035,175	361,055	325,275	11,709,900
5	11,709,900	351,297	325,275	11,384,625
6	11,384,625	341,539	325,275	11,059,350
7	11,059,350	331,781	325,275	10,734,075
8	10,734,075	322,022	325,275	10,408,800
9	10,408,800	312,264	325,275	10,083,525
10	10,083,525	302,506	325,275	9,758,250
11	9,758,250	292,748	325,275	9,432,975
12	9,432,975	282,989	325,275	9,107,700
13	9,107,700	273,231	325,275	8,782,425
14	8,782,425	263,473	325,275	8,457,150
15	8,457,150	253,715	325,275	8,131,875
16	8,131,875	243,956	325,275	7,806,600
17	7,806,600	234,198	325,275	7,481,325
18	7,481,325	224,440	325,275	7,156,050
19	7,156,050	214,682	325,275	6,830,775
20	6,830,775	204,923	325,275	6,505,500
21	6,505,500	195,165	325,275	6,180,225
22	6,180,225	185,407	325,275	5,854,950
23	5,854,950	175,649	325,275	5,529,675
24	5,529,675	165,890	325,275	5,204,400
25	5,204,400	156,132	325,275	4,879,125
26	4,879,125	146,374	325,275	4,553,850
27	4,553,850	136,616	325,275	4,228,575
28	4,228,575	126,857	325,275	3,903,300
29	3,903,300	117,099	325,275	3,578,025
30	3,578,025	107,341	325,275	3,252,750
31	3,252,750	97,583	325,275	2,927,475
32	2,927,475	87,824	325,275	2,602,200
33	2,602,200	78,066	325,275	2,276,925
34	2,276,925	68,308	325,275	1,951,650
35	1,951,650	58,550	325,275	1,626,375
36	1,626,375	48,791	325,275	1,301,100
37	1,301,100	39,033	325,275	975,825
38	975,825	29,275	325,275	650,550
39	650,550	19,517	325,275	325,275
40	325,275	9,758	325,275	0

Working capital 3,238,928

Year	Principal Year start	Interest	Repayment	Principal Year end
1	2,429,196	315,795	2,429,196	0
2	0	0	0	0

Salvage value at the end of 20 years

7,912,000

