Pre-feasibility study on granite quarry for aggregate: A case study at Kanchanaburi province, Thailand.

Mr. Bee Ziyivang

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
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บี สิยิวัง : การศึกษาความเป็นไปได้เบื้องต้นของเหมืองหินแกรนิตเพื่อผลิตหินก่อสร้าง : กรณีศึกษาที่จังหวัดกาญจนบุรี ประเทศไทย. (Pre-feasibility study on granite quarry for aggregate: A case study at Kanchanaburi province, Thailand.) อ.ที่ปรึกษาหลัก : รศ.สมศักดิ์ สายสินธุ์ชัย, อ.ที่ปรึกษาร่วม : ดร.ราฟาเอล บิสเซ่น

การวิจัยนี้มีจุดประสงค์เพื่อการวางแผน และการออกแบบเหมืองในระยะยาว การคำนวณเครื่องจักรที่จำเป็นในการดำเนินงาน การวิเคราะห์ทางการเงินในการทำเหมือง และโรงโม่หิน การประเมินปริมาณสำรองแร่ และการออกแบบเหมืองโดยใช้โปรแกรม MineSight (Ver. 9.50) ส่วนแบบจำลองกระแสเงินสดคิดลด (Discounted Cash Flow) จะถูกใช้ในการประเมินสภาพทางการเงินของโครงการ จากการศึกษาพบว่าการทำเหมืองเปิดหน้าดินเป็นวิธีการที่เหมาะสมในการวางงแผน และออกแบบ ปริมาณสำรองแร่เท่ากับ 48.4 ล้านตัน โดยอัตราการผลิตประมาณ 2.4 ล้านตันต่อปี ใช้เวลาในการดำเนินโครงการ 22 ปี โดย ภายในปีแรกจะเป็นช่วงเตรียมการ และอีก 21 ปีเป็นชวงการทำเหมือง เงินทุนทั้งหมดที่ต้องใช้ในการทำโครงการนี้ประมาณ 598 ล้านบาท และ 148 ล้านบาทสำหรับค่าใช้จ่ายในการดำเนินกิจการรายปี จากผลการวิเคราะห์แบบจำลองกระแสเงินสดคิดลดแสดงให้เห็นว่า NPV ที่อัตราการคิดลด13.4% เท่ากับ 2,335 ล้านบาท และ MIRR เท่ากับ 22.4% และ ระยะเวลาคืนทุนเท่ากับ 1.6 ปี การวิเคราะห์ความอ่อนไหวทางการเงินพบว่าค่าอ่อนไหวมากทีสุดคือราคาหินก่อสร้าง ตัวอย่างเช่น ถ้าราคาหินเพิ่มขึ้น 30%จะทำให้ค่า NPV ที่อัตราคิดลด 13.4% เพิ่มขึ้นจาก 2,335 เป็น 3,442 ล้านบาท ในทางตรงกันข้าม หากราคาหินก่อสร้างลด 30% ทำให้ค่า NPV ที่อัตราการคิดลด 13.4% ลดลง 53.62%.

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Bee Ziyivang : Pre-feasibility study on granite quarry for aggregate: A case study at Kanchanaburi province, Thailand.. Advisor: Assoc. Prof. SOMSAK SAISINCHAI Co-advisor: RAPHAEL BISSEN, Dr.rer.nat.

This study aims to develop long term mine planning and design, equipment requirement calculation, and financial model analysis of mining and crushing plant. The ore reserve estimation and pit design carried out by using MineSight software (Ver. 9.50). A discounted cash flow model (DCF) and sensitivity analysis used to evaluate the financial project. Based on our study, the open-pit mining method was advisable for mine planning and design. Ore reserve estimated to 48.4 Mtons under the mining operation of 2.4 Mtos per year. The project time frame is 22 years which spends 21 years for operation and one year for preparation and development. The project required of 598 million baht for capital cost, spent 148 million baht for operating costs annually. The financial model indicated that $NPV_{13.4\%}$ is 2,335 million baht, MIRR obtained 22.41%, and 1.6 years of payback period. The sensitivity analysis of the financial model shown that the most sensitive value was the aggregate price. For example, a 30% increase in aggregate price leading to raised $NPV_{13.4\%}$ up from 2,335 million baht to 3,442 million baht. In contrast, a decrease of 30% in aggregate price resulted in $NPV_{13.4\%}$ reduced by 53.62%.

Field of Study:	Georesources and Petroleum Engineering	Student's Signature ....
Academic Year:	2019	Advisor's Signature ....
		Co-advisor's Signature ....

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Chapter 1
Introduction

1.1 Granite

Granite is an igneous rock of visible crystalline formation and texture composed of feldspar, quartz and accessory minerals, such as zircon, apatite, magnetite, and ilmenite. Granite is usually whitish or gray with a speckled appearance caused by the darker crystals. The specific gravity of granite ranges from 2.63 to 3.30. It has greater strength than sandstone, limestone or marble and is correspondingly more difficult to quarry. It is now one of the most essential building materials for the decoration, durability and protection of the buildings.

Granite has been used for thousands of years as a construction material, a dimension stone, an architectural stone, a decorative stone, and used to manufacture a wide variety of products. Granite is used in buildings, bridges, paving, monuments, and many other exterior projects in the form of crush rock. Crushed rock is the most basic use of granite under subbase and base material in road and highway construction and used as crushed stone media in sewage system drain fields and as a base material for foundations and construction slabs.

1.2 Aggregate.

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Aggregate is a fundamental construction component that spread throughout the country wherever building or construction operation takes place. As a result of this, the aggregate industry is considered as one of the most widely dispersed producing industries in existence (Barksdale, 1991). Aggregates are divided into:

- Primary aggregate, which are extracted from quarries, pits and in the case of marine aggregates, the seabed.
- Secondary aggregate, which are by-product of industrial and mining processes.
- Recycled aggregate, which are produced, for example from demolition sites and construction waste.

Aggregates are classified by the grade (i.e size) of the material:

- Fine aggregates are generally materials with a particle size of less than 5mm diameter. Fine aggregates include dust produced by crushing rock, gravel, recycled or secondary materials as well as naturally occurring sands.
- Coarse aggregates are material that are produced to a specific grading above 5mm diameter. In most application the sizes used are 10mm, 14mm, 20mm, 28mm and 40mm, although larger materials may be produced.
- Granular aggregates do not have a uniform size and are used to provide stability in foundation layers and bulk fill application. Their composition is a combination of course and fine materials, with coarse components providing strength and bulk while the finer components bind the material providing stability when compacted.

It is utilized in several ways in construction activity in term resisting the overall load of roads construction, load-bearing from railroad ties, water drainage facility and keep down a plant that might interface with the track structure as rail ballast, reduces shrinkage and cracks and to strengthen the structure as a concrete, and also use for water filtration and sewage treatment processes.

1.3 Aggregate market situation

Aggregate industries have evolved from small, family-owned business to an industry that consolidated and merged into a large company. According to Production Complexity Index (PCI) aggregates produced from pebbles, gravel, broken and crushed stone are the 1147th most traded product and the 3781st most complex product in 2017. The export leaders of pebbles, gravel, broken and crushed stone for aggregate are China ($223M), Norway ($178M), Germany ($146M), the United Arab Emirates ($123M) and Malaysia ($119M) in the total of $1.54 billion under the sharing market of Asia and Europe 43% and 56% respectively. In contrast, the top importers of aggregate are the Netherlands ($169M), Singapore ($167M), Hong Kong ($138M), Kuwait ($124M) and Russia ($111M) (OEC, 2017).

Table 1 Top ten exporters of aggregate

Exporter	Value($M)	Percentage (%)
China	223,973,852	15.00%
Norway	178,822,179	12.00%
Germany	146,530,138	9.50%
The United Arab Emirates	123,829,317	8.00%
Malaysia	119,720,570	7.80%
Belgium-Luxembour	97,610,041	6.30%
France	93,240,007	6.00%
Indonesia	77,750,353	5.00%
belarus	76,945,117	5.00%
Ukraine	51,853,866	3.40%

Table 2 Top ten importers of aggregate

Importer	Value($M)	Percentage (%)
Singapore	167,243,702	11.00%
Netherlands	169,884,516	11.00%
Hong Kong	138,399,906	9.00%
Kuwait	124,250,986	8.10%
Russia	111,936,526	7.30%
Switzerland	96,714,560	6.30%
France	96,915,076	6.30%
Belgium-Luxembourg	63,164,758	4.10%
Denmark	53,558,784	3.50%
Germany	50,227,406	3.30%

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Table 3 Aggregate market sharing of Thailand

	Value($)	Percentage (%)
Export	13,912,595	0.90%
Import	160,228	0.01%

Aggregate consumption has increased over the past 20 years from US$ 688 million in 1995 to 2.5 billion in 2017 though out the last decade. In 2006, the aggregate consumption growth up substantially to US$ 1.4 billion and rise to US$ 2.5 billion in 2014.

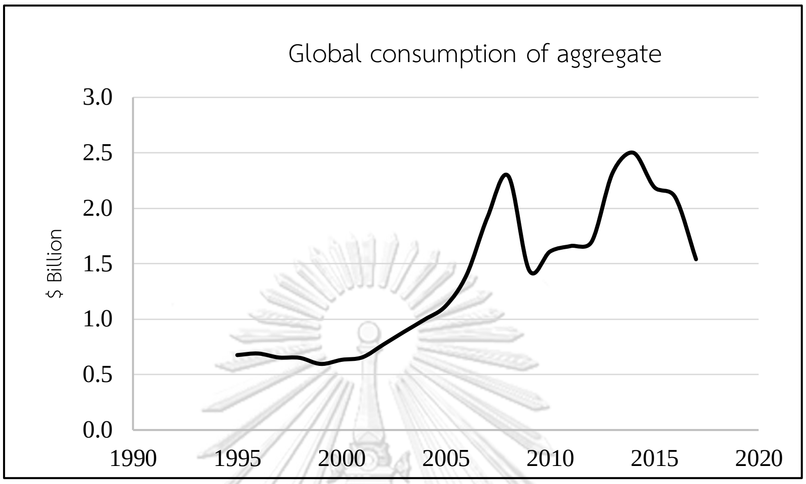

Figure 1.1 Global consumption of aggregate

1.4 Quarry industry status in Thailand

Construction activity is expected to improve, supported by many government constructions projects such as airports, railway construction, new road, and housing for low-income people. The private sector is expanding new factories to increase production. The demand from the real estate sector, e.g. single-family homes and allocations, is still high. Investments from the public and private sectors will have a positive impact on businesses related to all types of construction materials (Tangchawal, 2006).

Office of Transport and Traffic Policy and Planning indicated that infrastructure (railroad) of Thailand would be developed from 4,143 km to 5,557 km 6,934 km and 8,852 km in 2017 to 2021, 2026, and 2036 respectively (OTC, 2017). In Thailand, passenger and freight transport mainly depend on road transport. The proportion of domestic passengers traveling by road, rail, and air are at 74%, 21%, and 5% respectively (Jaensirisak, Paksarsawan, Luathep, & Fukuda, 2016).

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Over the past ten years, the trend of granite production increased 5% on average, especially during 2011 to 2017 the number of granite industries rose to 7.27% (DPIM, 2018).

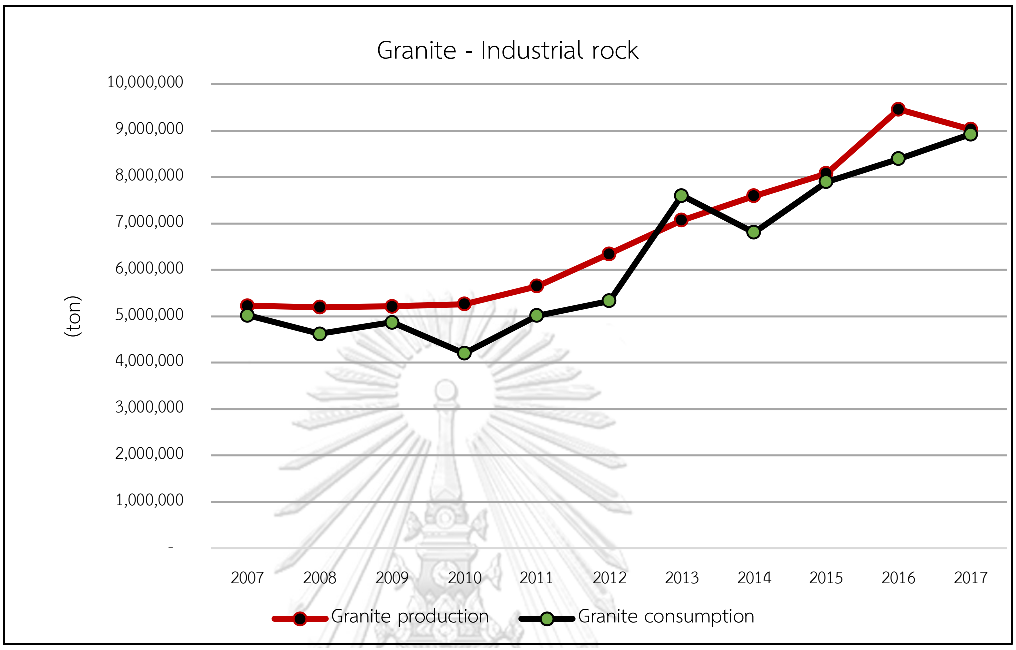

Figure 1.2 The status of granite industrial rock in Thailand

There are only in a few provincial areas which lack rock materials in the short term. To solve this problem, limestone aggregate can be substituted with granite aggregate in those areas. Most of granite is located in the western, northern and southern parts (DMR, 2012).

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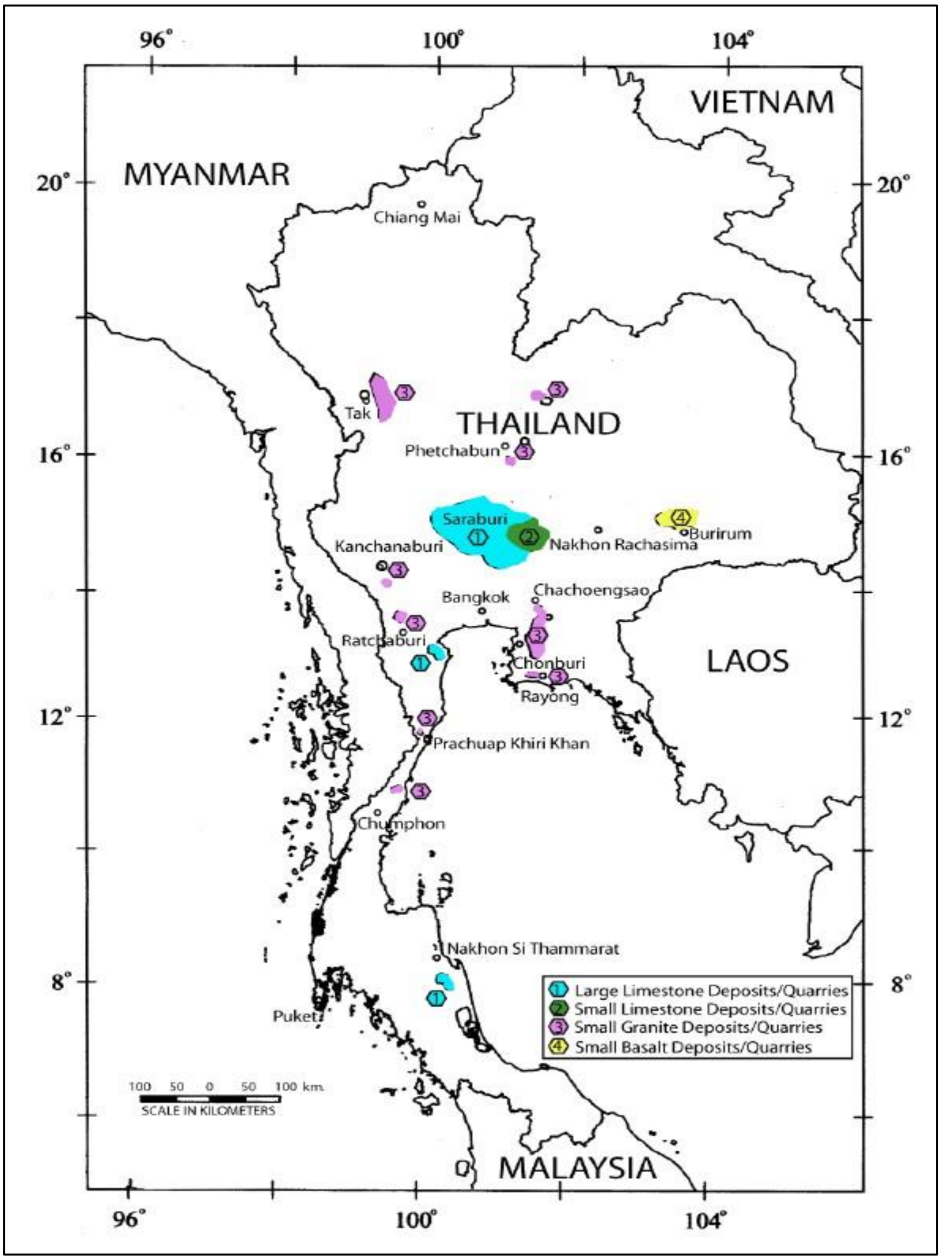

Figure 1.3 Quarries deposit location

According to the report on the potential mineral resource of Thailand released by the Department of Mineral Resource show that, the resource estimation of quarry especially granite and limestone are 11 billion tons and 294 billion tons respectively (DMR, 2012).

Table 4 Industrial rock resource estimation (tone)

Rock type	Reserve (ton)	Resource (ton)
Limestone	1,867,331,324	294,867,549,364
Basalt	89,570,412	42,189,231,653
Granite	259,897,422	11,259,990,171
Andesite	150,427,487	16,149,947,034
Sandstone	30,011,490	31,030,392,461

1.5 Study area

Silasiam mine located at Tha Muang District, Kanchanaburi, western Thailand, 129 km from Bangkok. A concession area covers approximately 288,000 square meters. Figure 1.4 present the location of mine. It is well located to meet the demand for stone in both Bangkok and the local construction markets.

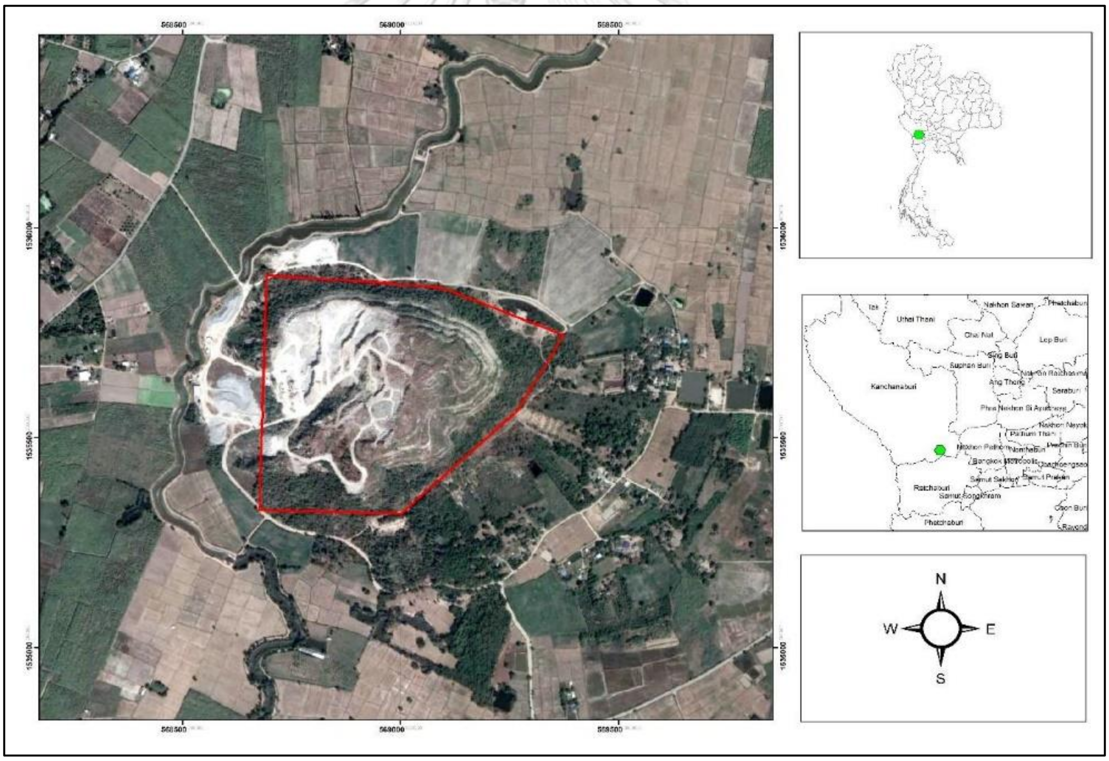

Figure 1.4 Location of study area

1.6 Objectives

The objectives of this study cover main issues such as mine planning, mine design and financial analysis. The specific aims of the study are to:

- Develop long term mine planning and design.
- Equipment requirement and selection.
- Mining and crushing plant financial analysis.

1.7 Scope of work

This project focusses on the technical and financial analysis of the granite quarry project of Silasiam mine at Tha Muang district, Kanchanaburi province, Thailand, by consideration of local factors and technical requirements such as design parameters, mine operation, production planning, equipment require, crushing plant and estimation of the capital cost (CAPEX), operating cost (OPEX), revenue unit profit or cash inflow and cash outflow of the project. A discounted cash flow model (DCF) and sensitivity analysis used to evaluate the project financial in this study.

1.8 Expected benefits

This study aims to develop the quarry project under an engineering principle and help key players to make informed decisions on whether to open mine or investment and this study provides a source of information on the latest developments and trends that can be useful for several students.

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Chapter 2
Theory and literature review

2.1 Geometrical consideration

Ore deposits are being mined by open-pit techniques from the top down in a series of horizontal layers of uniform thickness called benches. Mining starts with the top bench and after a sufficient floor area has been exposed the next layer can begin. The process continues until the bottom bench elevation is reached and the final pit outline achieved. To access the different benches a road or ramp must be created. Stable slopes must be created and maintained during the creation and operation of the pit. The slope angle is an important geometric parameter that has a significant economic impact. Open-pit mining is very highly mechanized. Each piece of mining machinery has an associated geometry both related to its own physical size, but also with space, it requires to operate efficiently. There is a complementary set of drilling, loading and hauling equipment which requires a certain amount of working space.

2.1.1 Basic bench geometry

The basic extraction component in an open pit mine is the bench. Bench nomenclature is shown in Figure 2.1. Each bench has an upper and lower surface separated by distance of bench height. The exposed sub vertical surfaces are called the bench face. They are described by the toe, the crest and the face angle. The bench face angle can vary considerably with rock characteristic, face orientation and blasting practices. It varies from about 55 to 80 degree depending on the type of rock. A typical initial design value might be 65 degrees.

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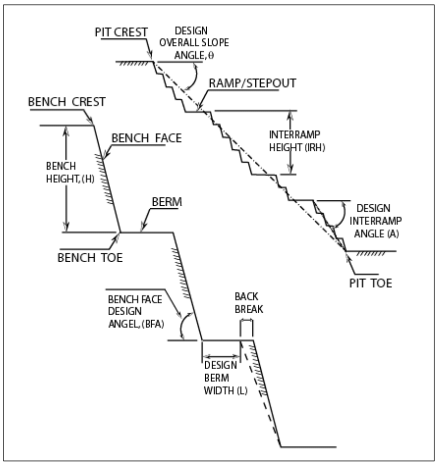

Figure 2.1 Pit slop angle and bench component

The purpose of benches is to:

- Collect the material which slides down from benches above.
- Stop the downward progress of boulders.

During the primary extraction, a safety bench is generally left on every lift on every level. The width varies with the bench height. Generally, the width of safety bench is of the order of 2/3 of the bench height. At the end of mine life, the safety benches are sometimes reduced in width to about 1/3 of benches height. In addition, to leaving the safety benches, berms of broken materials are often constructed along the crest. These serve the function of forming a 'ditch' between the berm and the toe of the slope to catch falling rocks. Recommendation of design catch bench geometry given in Table (Hustrulid, Kuchta, & Martin, 2013b)

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Table 5 Typical catch bench design dimensions

Bench height m	Impact zone m	Berm height m	Berm width m	Min bench width m
15	3.5	1.5	4	7.5
30	4.5	2	5.5	10
45	5	3	8	13

There are many different factors which influenced the bench dimensions selection. Common bench height in large open pit is 15 meters. For smaller pits, the value might be 12 meters. A typical value could be 7.5 m in a small gold mine. In general, the bench height should be matched to the loading equipment. A rule of thumb is that the bench should not be greater than the sheave wheel. Operating in benches with heights greater than this sometimes result in overhangs which endanger the loading and other operation. At one time, bench heights were limited by drilling depth, but modern drills have largely removed such restrictions.

2.1.2 Pit slop geometry

Stability should be considered in pit design stage. Slope design information involved soil and rock characteristic, structural geology, ground water condition, overall slopes as width, height, slopes angle and slopes stability. The slopes and benches are connected from crest to toe of each bench. Overall pit slop angle measured from lowest toe to highest crest. Pit slop indicated in Figure 2.1. The slope stability in each open pit mine is different depending on wall height or depth of open pit mine.

A general statistic estimates of overall pit slope angle in real mine operation indicated that in clay mine the overall slop is 16-45 degree depending on water content, sand mine estimated 22-37 degree, weather rock mine is 35-50 degree and a strength rock mine is approximately 45-80 degrees (Annels, 2012). Equation 1 presented the overall pit slop calculation.

$$(\phi, Overall) = \tan^{-1}\left[\frac{\mathrm{No.Bh} \times \mathrm{Bh}}{\mathrm{No.Bw} \times \mathrm{Bw} + \left(\frac{\mathrm{No.bh} \times \mathrm{Bh}}{\tan\beta}\right)}\right] \qquad \text{Eq. 1}$$

2.2 Mine planning and design

There are many factors affecting the size and shape of the pit which must be properly understood and used in the planning of any open-pit operation. The key affects the pit design including mineralization location and geology, deposit extent, topography, production requirement, bench and pit slop geometry, road grades, operating cost.

Planning is obviously an ongoing activity throughout the life of the mine. Plans are made which apply to different time spans. There are two kinds of production planning which correspond to different time spans (1) Operational or short-term production planning is necessary for the function of an operating mine. (2) Long-range production planning is usually done for feasibility or budget studies. It supplements pit design and reserve estimation work and is an important element in the decision-making process (Couzens, 1979).

2.2.1 Life of Mine

Mine life is estimated from ore reserve divide required production per year to meet the market requirement. LOM equation indicated in Eq 2.

$$\text{Mine life} = \frac{\text{Ore reserve}}{\text{Annual production}} \qquad \text{Eq. 2}$$

2.2.2 Mine operation

Mine operation is the concept following the planning stage required more data such as ore reserve, material excavated in each year, equipment capacity, operating cost, sale price, etc. This information is applied into operation plan, which must be alteration changed depending on the condition of the mine operation (Michael Noakes & Lanz, 1993).

Operation unit employed in the production cycle that is grouped into breakage and materials handling. Breakage includes drilling and blasting, and material handling.

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- Drilling: it is an important unit operation in mining. It requires for a variety of mining or mining-related activities including blasting, ground support installation, utility installation, dewatering, exploration. The term drilling is used for smaller-diameter holes with a few exceptions such as shaft drilling and raise drilling. The majority of blasthole drilling is performed by two primary methods such as: percussive drilling and rotary drilling.

- Blasting and blast design: most of the rock requires blasting prior to excavating. It is an important of unit operation for many mines. Because if it is not performed successfully the viability of the mine frequently becomes jeopardized. The principal factors that influence blasting results are the properties of the explosives being used, their distribution and initiation sequence in the blast, the overall blast geometry, the rock structure and other properties.

- Loading: the introduction of the large 7.6 m^3 to 23 m^3 capacity hydraulic backhoes now available to the mining industry. The backhoe allows the choice of locating the truck on top of the overburden or in deep mineral, which can be a significant advantage in mines. As a result, the backhoe is easier to service; haul truck ramps are reduced or eliminated. The haul truck loading point can be in front and slightly to either side of the backhoes, the cycle time may be significantly reduced.

- Hauling: Off-highway trucks is used for moving ore and waste material from the pit to stockpile or processing plant. Off-highway trucks can be classified into three main types: (1) conventional rear dump: (2) tractor-trailer, bottom, side, and rear dump; and (3) integral bottom dump.

2.2.3 Crushing plant

The basic goal for the crushing plant is to reduce the rock size in order to meet required production requirements, operates at a competitive cost, complies with today's tough environmental regulations, and be able to build at a reasonable price despite the rising costs of equipment, energy and construction labor. The design parameters principle drives crushing plant including production requirement, ore characteristics, operational considerations, climatic conditions, capital cost, safety and environment, life of mine and maintenance requirement (Boyd, 2003). There are three main steps in designing a good crushing plant: (1) process design, (2) equipment selection, and (3) layout. The first two are dictated by production requirements and design parameters, but the layout can reflect the input, preferences and operational experience of several parties.

2.3 Financial analysis

2.3.1 Future and present value

Future value (*FV*) is the value of a current asset at a specified date in the future based on an assumed rate of growth.

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$$FV = PV \times (1+r)^n \qquad \text{Eq. 3}$$

Present value (*PV*) is the current value of a future sum of money or stream of cash flows given a specified rate of return. Future cash flows are discounted at the discount rate, and the higher the discount rate, the lower the present value of the future cash flows. Determining the appropriate discount rate is the key to properly valuing future cash flows, whether they be earnings or obligations.

$$PV = \frac{FV}{(1+r)^n} \qquad \text{Eq. 4}$$

2.3.2 Cash flow

Cash flow estimation is an integral part of the valuation and capital budgeting process. Cash flow estimation is a necessary step for assessing investment decisions of any kind. The estimation of cash flows is done through the coordination of wide range of professionals involved in the project.

for an elementary cash flow calculation is:

  Gross revenue
– Operating expense
– Depreciation
– Depletion
= Taxable income
– Tax
= Profit
+ Depreciation
+ Depletion
– Capital costs

= Cash flow

2.3.3 Discounted cash flow

Discounted cash flow (DCF) is a valuation method used to estimate the value of an investment based on its future cash flows. Discounted cash flow analysis attempts to figure out the value of a company today, based on projections of how much money it will generate in the future (Investopedia, Mar 16, 2020).

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Discounted cash flow analysis finds the present value of future cash flows discounting by discount rate. A present value estimate is then used to evaluate a potential investment. If the value calculated through discounted cash flow is higher than the current cost of the investment, the opportunity should be considered.

$$DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n} \qquad \text{Eq. 5}$$

2.3.4 Net present value (NPV)

Net present value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a period. NPV is used in capital budgeting and investment planning to analyze the profitability of a projected investment or project. The NPV is defined as the present value of receipts less the present value of disbursements. If the NPV at the project's cost of capital is positive, then accepting the project adds value to the firm and vice versa (Investopedia, 2019b). The NPV method of evaluating the desirability of investment is mathematically represented by the following equation:

$$NPV = -CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n} \qquad \text{Eq. 6}$$

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$$NPV = -CF_0 + \sum_{n=1}^{n} \frac{CF_n}{(1+r)^n} \qquad \text{Eq. 7}$$

$$NPV = \sum_{n=1}^{n} \frac{NCF_n}{(1+r)^n} \qquad \text{Eq. 8}$$

Where CF_n is the expected cash flow each year, r is the discount rate for the project, and n is time periods. A project's net present value is positive (NPV>0) indicates to economic acceptable. Net present value equal zero (NPV = 0) mean the project break even. In contract, net present value is negative (NPV<0), the project considered to be uneconomic.

2.3.5 Modified Internal Rate of Return

The modified internal rate of return (MIRR) assumes that positive cash flows are reinvested at the firm's cost of capital and that the initial outlays are financed at the firm's financing cost. By contrast, the traditional internal rate of return (IRR) assumes the cash flows from a project are reinvested at the IRR itself. The MIRR, therefore, more accurately reflects the cost and profitability of a project (Investopedia, 2019a)

$$\text{MIRR} = \sqrt[N]{\frac{\sum \text{FV (Positive cash flows} \times \text{Cost of capital)}}{\text{PV (Initial outlays} \times \text{Financing cost)}}} - 1 \qquad \text{Eq. 9}$$

2.3.6 Payback period

The discounted payback period is a capital budgeting procedure used to determine the profitability of a project. A discounted payback period gives the number of years it takes to break even from undertaking the initial expenditure, by discounting future cash flows and recognizing the time value of money. The metric is used to evaluate the feasibility and profitability of a given project.

$$\text{Payback period} = \frac{\text{Initial Investment}}{\text{Net Annual Cash Inflow}} \qquad \text{Eq. 10}$$

2.3.7 Sensitivity analysis.

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The purpose of a sensitivity analysis is to concentrate the effect of change in a selective economic parameter on the economic viability of the project under the given set of assumptions while other parameters kept constant.

2.4 Related research

(Mireku-Gyimah & Ansah, 2017) presented an economic evaluation of a quarry. The purpose to this project is to estimate the revenue of granite quarry for aggregate. Production rate is 25,000 cubic meter per month for a major road infrastructure project. The granite reserve is 6,286,208 cubic meter and the average price is US$ 15 per cubic meter. The revenue was estimated by sale of the production at a different price and the quantity of each production. Estimated US$15.63/m3, the Weighted Average Price

(WAP) was used for monthly revenue based on the monthly production plan. Quotations of equipment from supply agencies in Ghana and overseas was used to estimate the capital cost. The operating cost was generated from drilling and blasting, mucking, hauling, road maintenance, crushing and screening, re-handling and loading, and supervision and labor. Information on this cost is assembled from AQL's current operation, a similar condition of quarries operating, and Awutu-Senya Municipality. an operating cost contingency allowance of 12% is provided. Working Capital determined as a portion annual Operating Cost, three months deemed appropriate. Using the Net Present Value (NPV) and the Internal Rate of Return, the investment decision criteria preferred on discounted cash flow technique. The project requires total capital cost of US$ 3.67 million, annual operating cost is US$ 1.72 million. Generated annual revenue of US$ 4.6 million. The project capital structure presented 80% equity and 20% loan. The NPV is US$ 5.17 million, and the IRR is 52.01%. the sensitivity analysis indicates that the project can withstand up to 40% drop in revenue, or over 60% increase in capital or operating cost. The risk profile indicates a probability of success of 98.2%.

(Kem & Pumjan, 2014) conducted research on a pre-feasibility study of limestone quarry development for cement industry in Cambodia. The study area is an approximate of 1,300 x 600 sq. meters, 21 drilling hole and 378 assays was contained. 3D block model was used to simplified quality block model description of a deposit. Drilling and blasting were the first stage of operation. The wheel leader, excavator and dump truck were used to loading and transportation the material to the waste dump and processing plant. Discounted cash flow analysis involving Weight Average Cost of Capital (WACC), Internal Rate of Return (IRR) and Net Present Value (NPV) was proposed for the project financial analysis. 204 million tons of ore resource, Inverse Distance Square Method was used to estimate. the ultimate pit (MP1) was selected by the pit optimization using the Lerch-Grossmann method yield with the mineable reserve of 30 million tons. 25 years mine life was estimated with the production rate of 1 million per year. The equipment consisted of 2 excavators, 5 trucks, and 1 loader for 550 tons

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per hour of limestone production. In term of financial the Net Present Value is US$ 193 million with the IRR 45 percent which is higher than the WACC of 15 percent.

(Olasehinde & Bute, 2014) published the pre-feasibility study of Ratcon quarry in Nigeria. The production from this project is for road construction, concrete, block industry and asphalt. The study is carried out with the aim of evaluating a proposed or ongoing project to ascertain its economic value for an investor who is interested in the establishment of the quarry. a result of study showed that, the quarry reserve is 75 million tons, the annual production rate is 2,500 ton per day, the life of mine is 115 years. The initial investment cost is US$ 18 million, with the annual operating cost is US$ 5.33 million and net profit is US$ 3.91. the project spends 6 years to recover the investment cost.

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Chapter 3

Scope of work

The study methodology is shown in Fig 3.1.

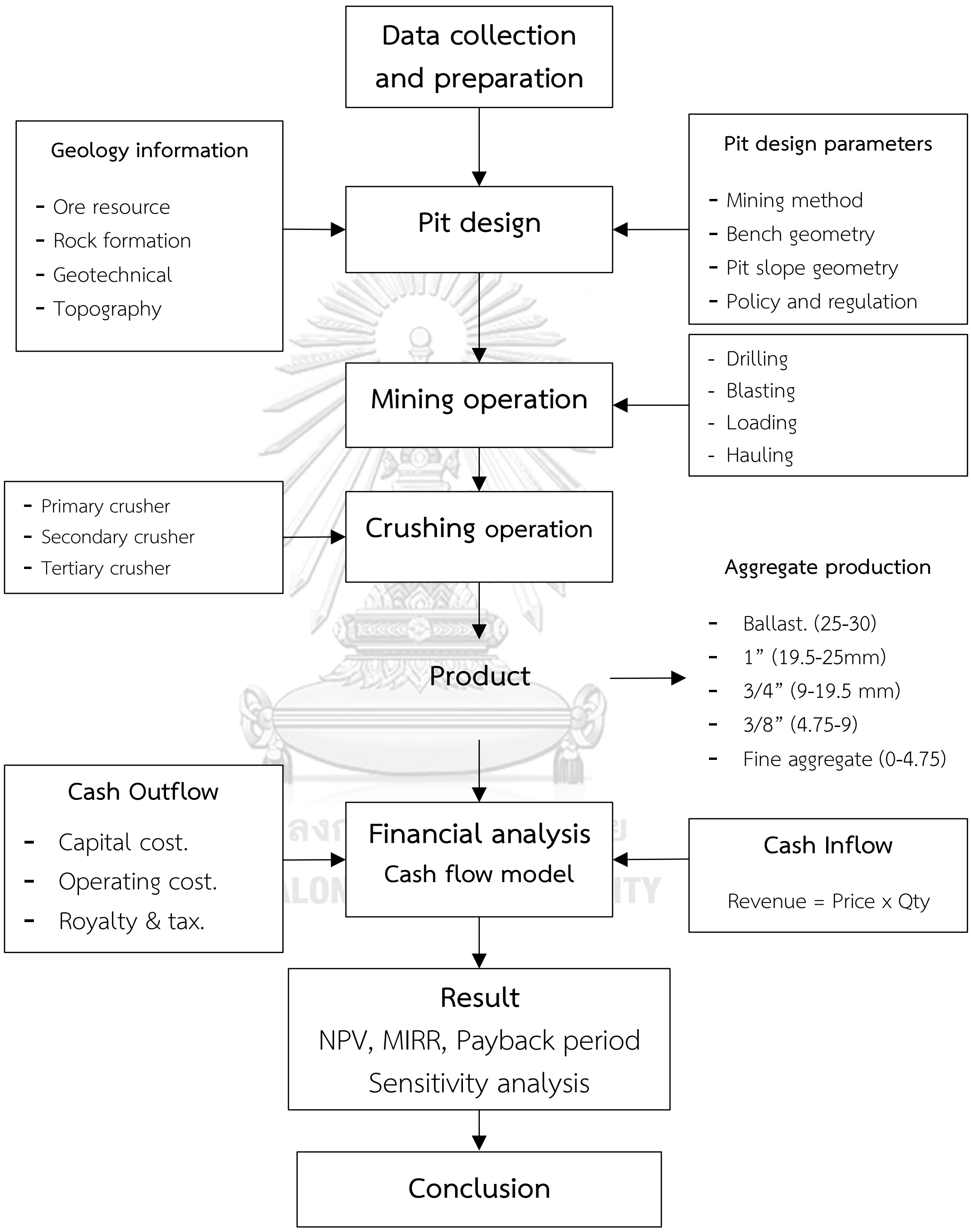

Figure 3.1 Flow chart of study

3.1 Data preparation

The coordinate of easting, nothing, elevation and the granite rock assay data collect on concession area. Coordinate data point edited in excel file (.csv) and imported to MS3D as point data then triangulated to 2D surface and wireframe. Contour map 5 meters interval was created from exploration data as shown in Figure 3.2. The setting of the topography is within the coordinate of 568400 – 569400 easting, 1535200 – 1536000 northing and the elevation is ranking from 43 – 113 MSL.

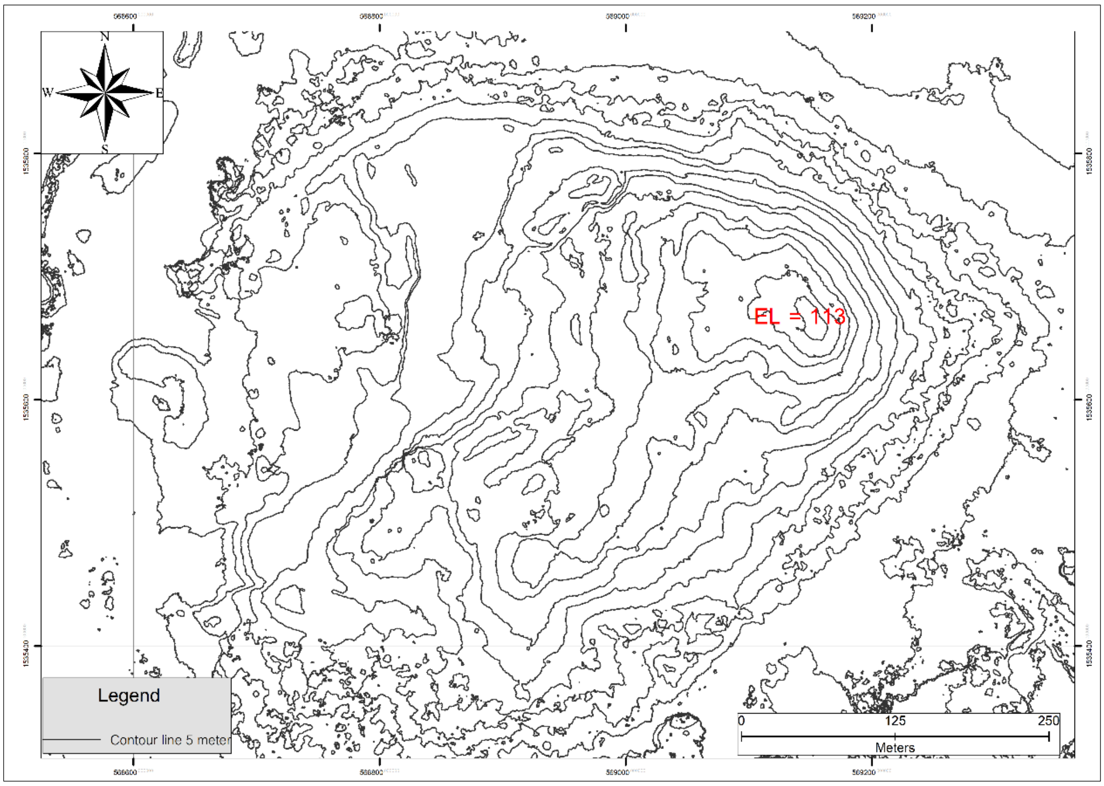

Figure 3.2 Topographic map of the study area

3.2 Physical and physical property tests

Physical test: sample collected on outcrop randomly of 10 kg per sample in three points such as GTM1, GTM2 and GTM3 at the coordinate of 0568804E-1535826N, 0568792E-1535826N, and 0568792E-1535526N respectively. The samples had been sent for testing at Department of Primary Industries and Mines 3 in Chiangmai province. The result showed that most of the sample is rock lumpy shape from 1 to 3 inch, fine to medium-grained. Table 6 presented physical test

Table 6 Physical test

Sample NO		Coordinate		Discription
		N	E	
GTM1	10 Kg	1535688	568894	Fine-grained biotite-muscovite granite
GTM2	10 Kg	1535682	568804	Fine-to medium-grained biotit-muscovite granite
GTM3	10 Kg	1535529	568792	Fine-grained biotite-muscovite granite

Physical property testing: sample collected randomly on outcrop in 4 x 4 inch rock lump of 30 kg per sample at the coordinate of GTM11 (0568894E-1535688N) and GTM12 (0568804E-1535826N). The samples sent to the Bureau of Rural Roads 10 (Chiangmai) for physical property testing. The result presented in Table 7.

Table 7 Physical property test

Sample NO		Coordinate		Abrasion Test Percent of Water (%)	Unit weight of Aggregate (%)	Apparent specific gravity	Water absorption (%)
		N	E				
GTM11	30 Kg	1535688	568894	31.71	1.617	2.603	0.608
GTM12	30 Kg	1535682	568804	29.48	1.632	2.579	0.234

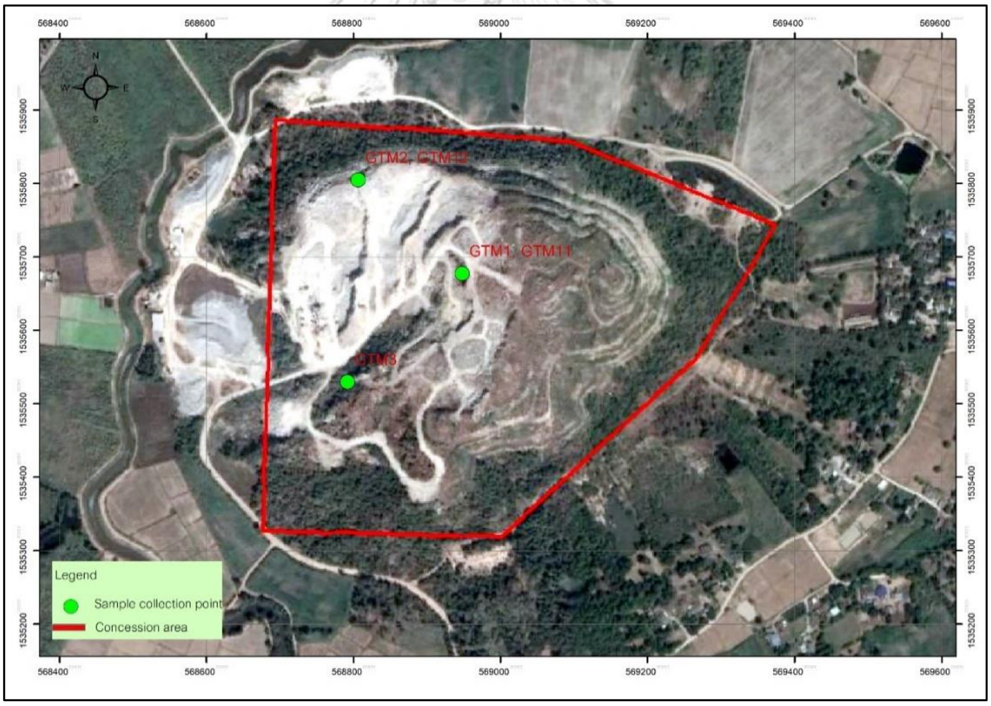

Figure 3.3 Sample collection point

3.3 Pit design and mine operation

MineSight software (Ver. 9.50) used for pit design and determine the optimum of the mine. Mine design data input obtained exploration include geology, material property, structure, hydrology, and mining regulation and policy of Thailand. Operation unit employed in the production cycle that is grouped into breakage and materials handling. Breakage includes drilling and blasting, and material handling consists of loading or excavating and haulage. In this study, the production cycle used consists of these unit operations:

Production cycle = drilling + blasting + loading + hauling

The equipment selection and requirements are based on production planning, mobile equipment capacity, the crusher plant capacity and marketing requirement. Then, the result of mine planning and design would present ore reserve, final pit limit, equipment unit, annual production, and life of mine.

3.4 Crushing plant

Jaw crusher proposed the bulk of primary crusher used. Cone crusher uses for fine crushing applications as secondary and tertiary crushers. The major equipment of primary crushing includes a crusher, feeder and conveyor belt. In addition, secondary and tertiary crusher circuits also consisted of the same equipment items with screens and surge storage.

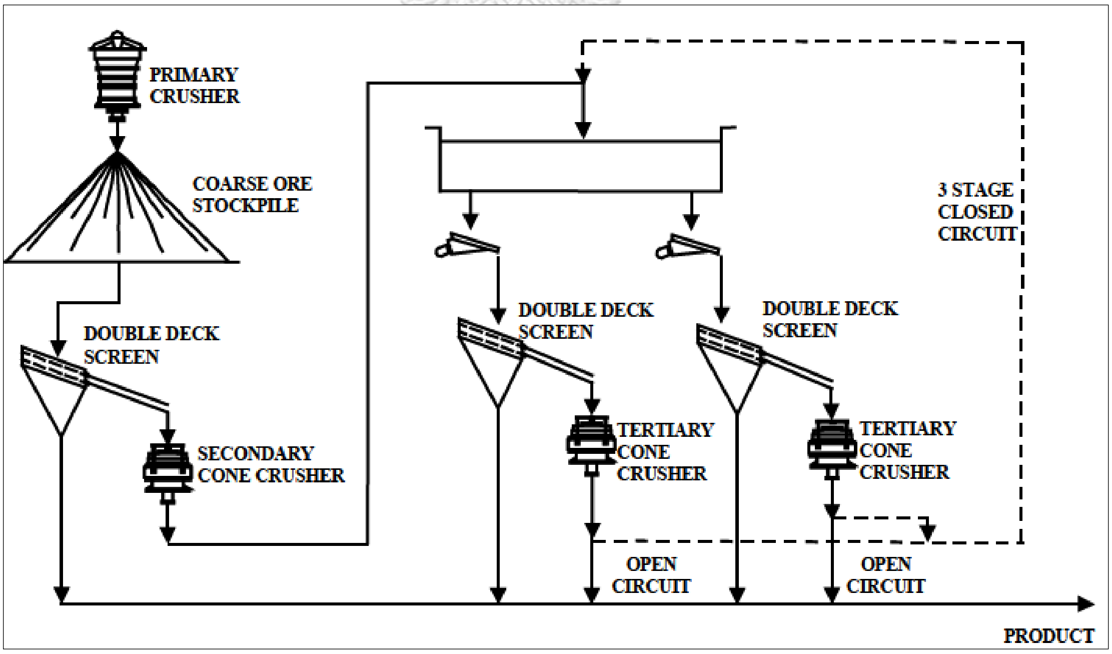

Figure 3.4 Three stage open / close circuit crushing plant

3.5 Financial analysis

Mine economics is one of the main aspects of a pre-feasibility study. It is significant for the confidence of the potential prior to investing in the mining project. The data driving in this the project include the source of money, capital cost, operating cost, royalty, tax, production price. The cash flow model consisted of net present value (NPV), the modified internal rate of return (MIRR), and the payback period used to analyze the finance of the whole project. The result of the financial analysis would present the break-even point for decision making.

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Chapter 4

Results and discussions

4.1 Mine planning and design

Fig 4.1 shown the location of mining operating site, crushing plant and office and camp. Infrastructure and crushing plant would spend one year for installation and construction.

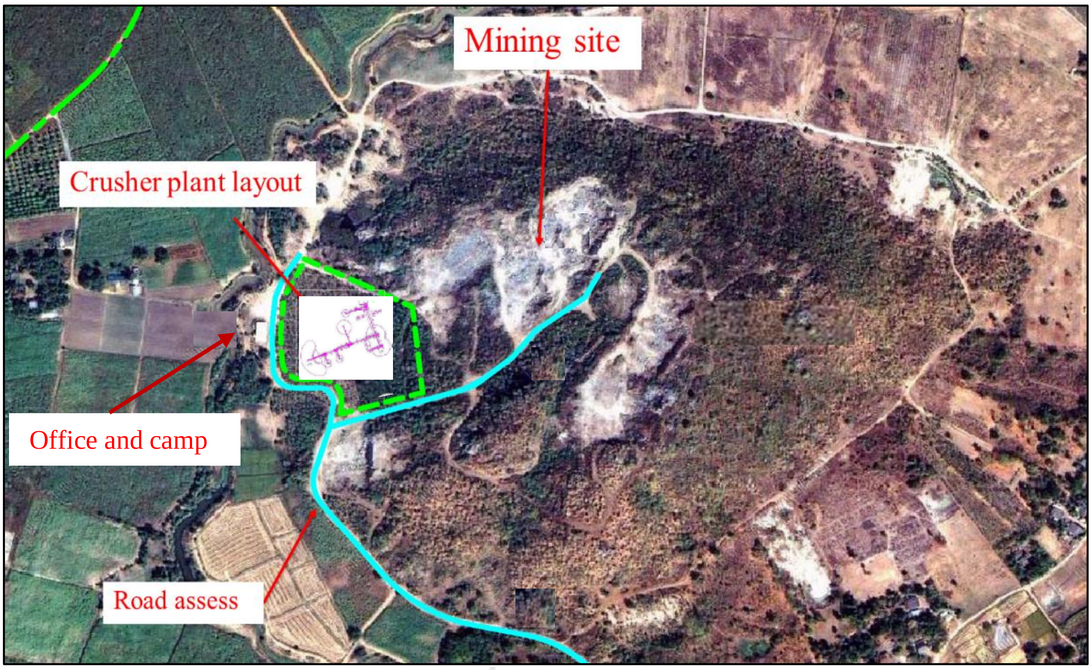

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Figure 4.1 Layout of the project

4.1.1 Reserve estimation

Reserves estimate is based on topographic map, contour lines and final pit design process and cost. The mineral reserve is the sum of the probable material which is scheduled for each phase of mine pit design. The volume of final pit design report as 19.3 million cubic meters. Mineral reserve summarizes in Table 8.

Table 8 Ore reserve estimaton

Production year	Elevation (m)		$\mathrm{Vol}(m)^3$	Annual production (ton)	Cumulative production (ton)
	From	To			
1	115	85	935,139	2,337,848	2,337,848
2	85	75	917,315	2,293,288	4,631,135
3	75	65	1,032,802	2,582,005	7,213,140
4	65	55	858,733	2,146,831	9,359,971
5	65	55	858,733	2,146,831	11,506,803
6	55	45	904,480	2,261,200	13,768,003
7	55	45	904,480	2,261,200	16,029,203
8	45	35	1,097,658	2,744,146	18,773,348
9	35	25	988,274	2,470,686	21,244,034
10	35	25	989,598	2,473,996	23,718,030
11	25	15	909,012	2,272,529	25,990,559
12	25	15	909,012	2,272,529	28,263,088
13	15	5	1,096,838	2,742,095	31,005,183
14	5	-5	1,029,194	2,572,985	33,578,168
15	-5	-15	1,067,657	2,669,143	36,247,310
16	-15	-25	959,674	2,399,185	38,646,495
17	-25	-35	857,403	2,143,508	40,790,003
18	-35	-45	809,595	2,023,988	42,813,990
19	-45	-55	917,600	2,294,000	45,107,990
20	-55	-75	928,040	2,320,100	47,428,090
21	-75	-85	421,222	1,053,055	48,481,145

4.1.2 Bench geometry and pit design parameters

Mine planning and design considered with respect to characteristics of geology structure, ore body, ore reserve, production planning, environment and society in that area. In this study, Mine planning was developed using a conventional open-pit hard rock mining method. Phase design includes all internal access roads and assures proper operating requirements for mining equipment. The overall slope provided by typical catch bench design dimensions and regulation and policy of Thailand. The parameters for mine designs are summarized in Table 9.

Table 9 Pit design parameters

Design Parameter	Parameters value
Hual Road Width Including Ditches and Berms	19 meters
Maximum Haul Road Grade	10%
Bench Height for Mining	10 meters
Bench Width for Mining	7 Meters
Face Angle of Benches	80 Degree
Overall Slope Angles Used	45 degree
Buffer zone	50 meters

According to the condition of geological, government regulation and different parameters, the haul road width indicate 3.5 times of the hauling truck width (Hustrulid, Kuchta, & Martin, 2013a), there is 10% of road grade, the bench face angle from toe to crest estimate to 80 degree with the bench width and high of 7 meters and 10 meters respectively.

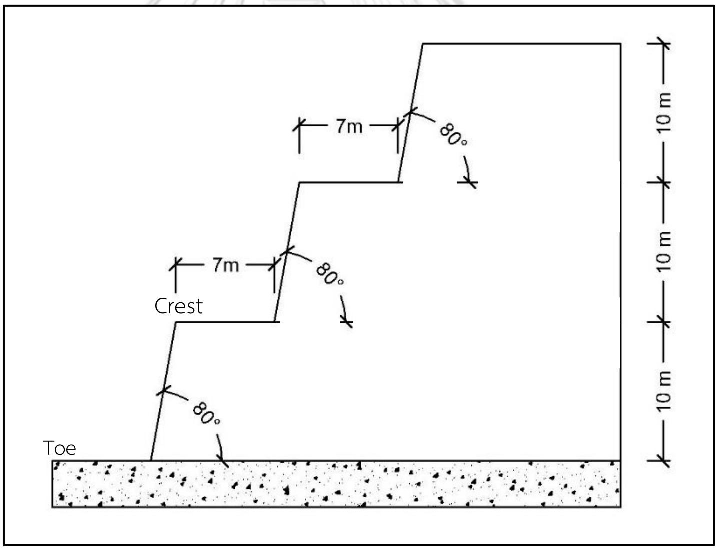

Figure 4.2 Bench geometry

4.1.3 Mine production plan

The mine production was planned to develop based on the phase design. The material contained within each pushback design was tabulated. It is assumed that all the materials are mined for input to the mine schedule process.

The mine schedule was developed to provide 2.4 million tons of mined material to the primary crusher every year (1,000 tons per day), while the rock would be breakage by drilling and blasting, mined with an excavator, and handling the material by hauling truck to the crushing plant to produce aggregate.

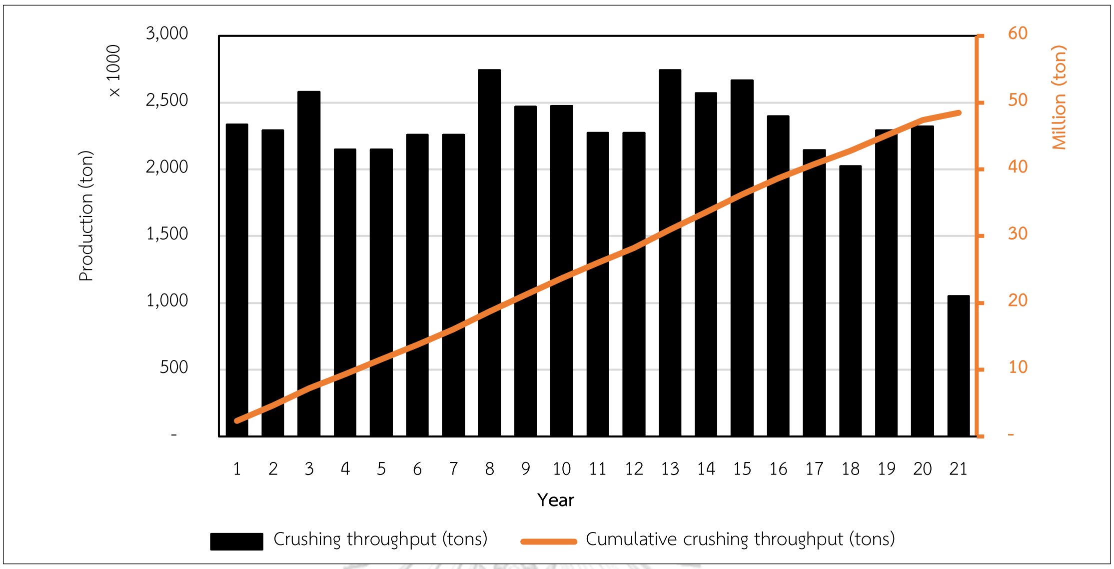

Figure 4.1 Annual mine production planning

In the process of developing mine operating strategy, multiple schedules were evaluated. The purpose of this work was to balance the capacity of equipment, production rate, and costs. Using the design average prices of 330 baht/tons granite aggregate, and a discounted rate of 13.4%. Base on the mineral reserve and mine production planning, the project requires an operation time of 21 years and spend one-years for developing and preparing after the permits are obtained.

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4.1.4 Pit design

Mine operation started to operate in vertical direction from the top down to the ground under the pit design parameters which shown in Table 9. The throughput requires 2.4 million tons per year for crushing. Details of pit stage design are provided in Appendix A.

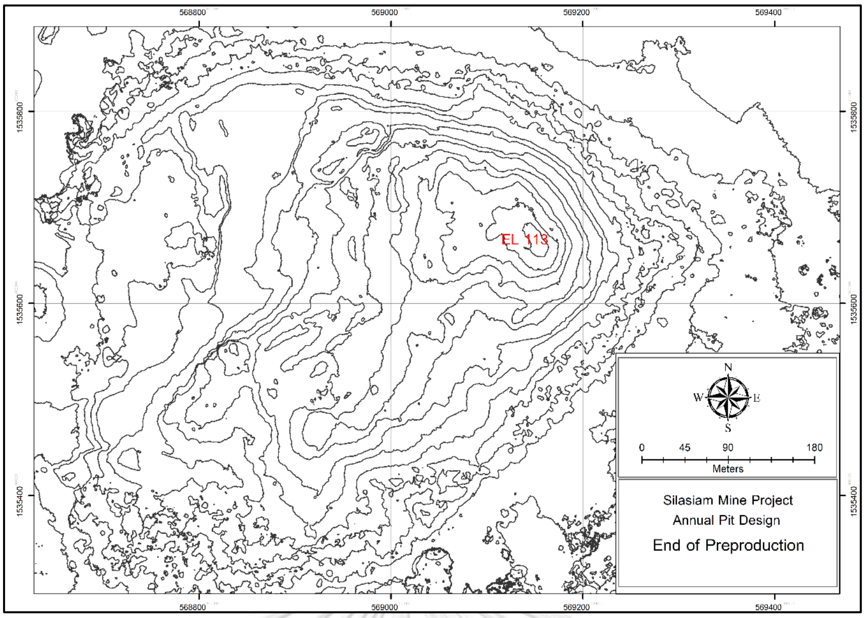

Figure 4.2 Annual open pit plan - End of Pre-production

In pre-production period, the building, warhorse, main haul road, facility, mobile equipment and crushing pant were prepared and installed.

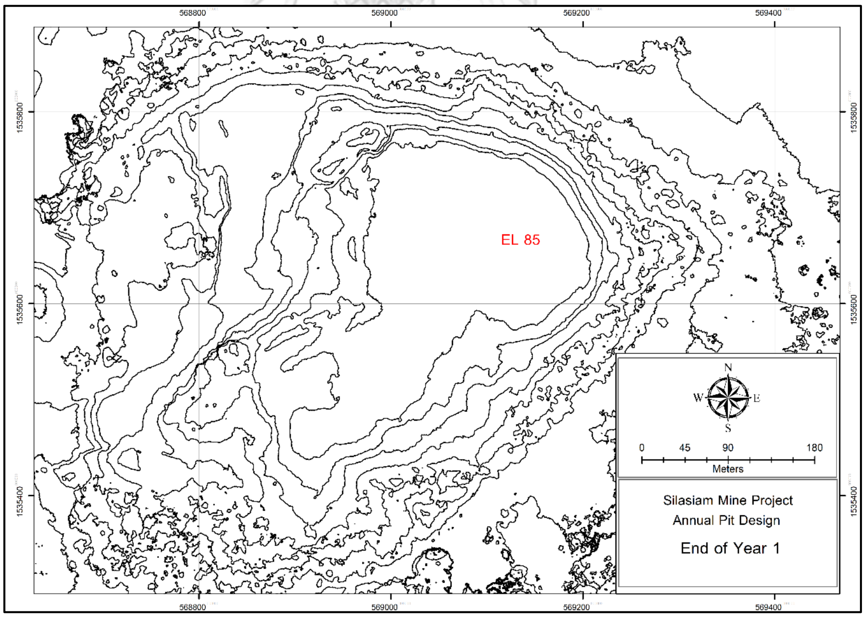

Figure 4.3 Annual open pit plan - End of year one

The first-year operation starts to mine at the top on the mountain from elevation 113 down to 85. Materials of 2.3 million tons or 0.93 million cubic meters be mined and transported to crushing plant.

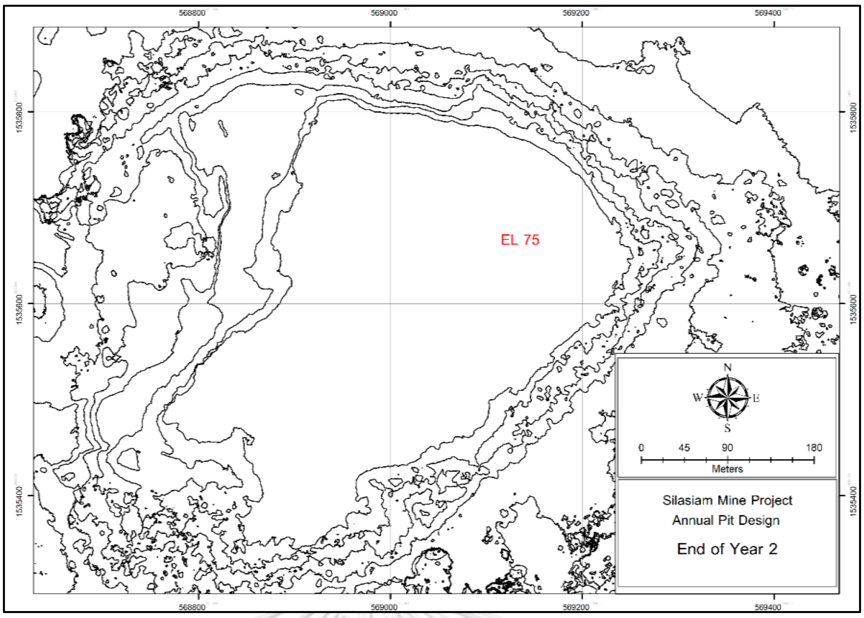

Figure 4.4 Annual open pit plan - End of year two

In the second year of operation, it began to mine from elevation 85 to 75 which obtained material of 2.2 million tons or 0.91 million cubic meters.

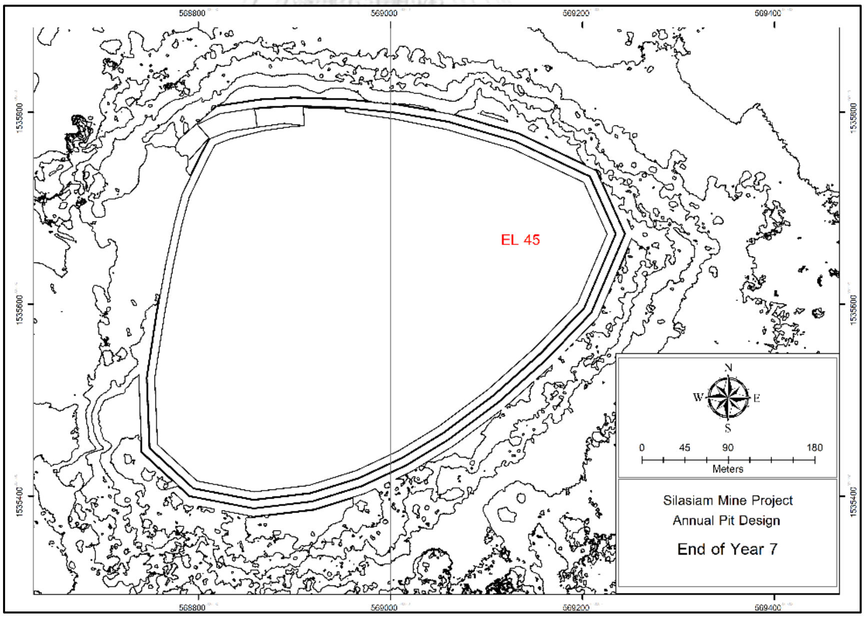

Figure 4.5 Annual open pit plan - End of year seven

In year seven, the operation able to produce the granite rock of 2.2 million tons at the elevation from 55 to 45.

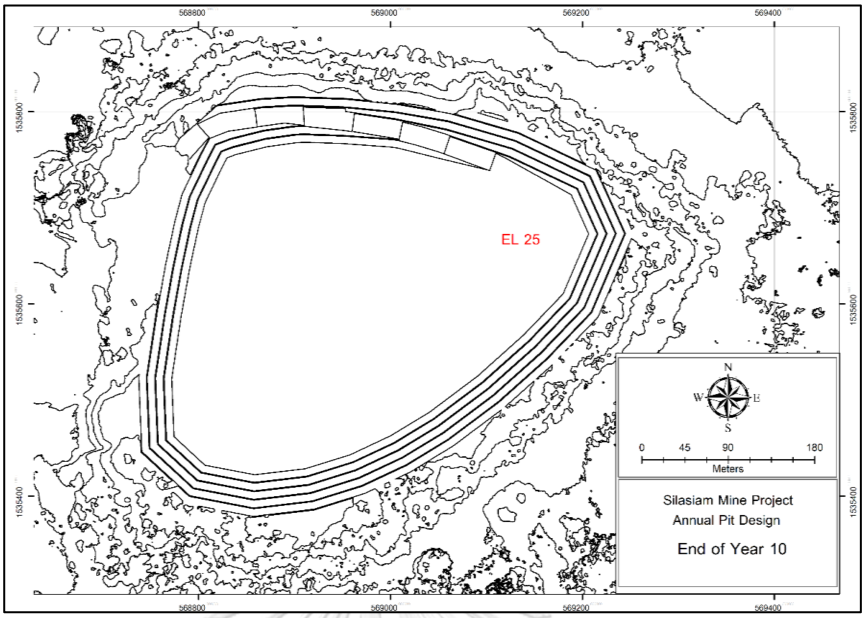

Figure 4.6 Annual open pit plan - End of year ten

This year, the project would be operated at the elevation from 35 to 25 which achieved material of 2.47 million tons. The cumulative quantity of granite material from year one to year ten approximately 23.17 million tons. Some of mine equipment might be replaced at this period.

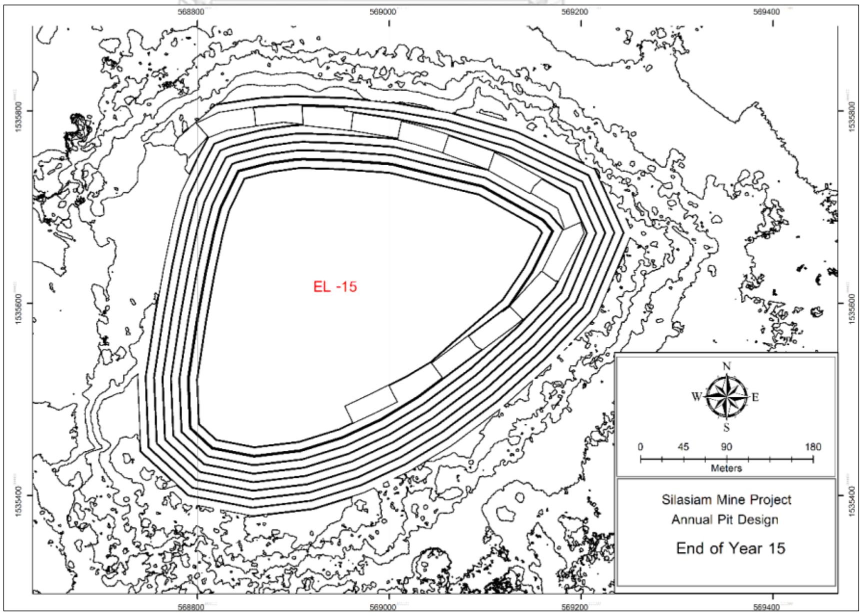

Figure 4.7 Annual open pit plan - End of year 15

Mine production in this year obtained 2.66 million tons. The pit was down to the elevation -15 at this period and the cumulative production is 36.24 million tons.

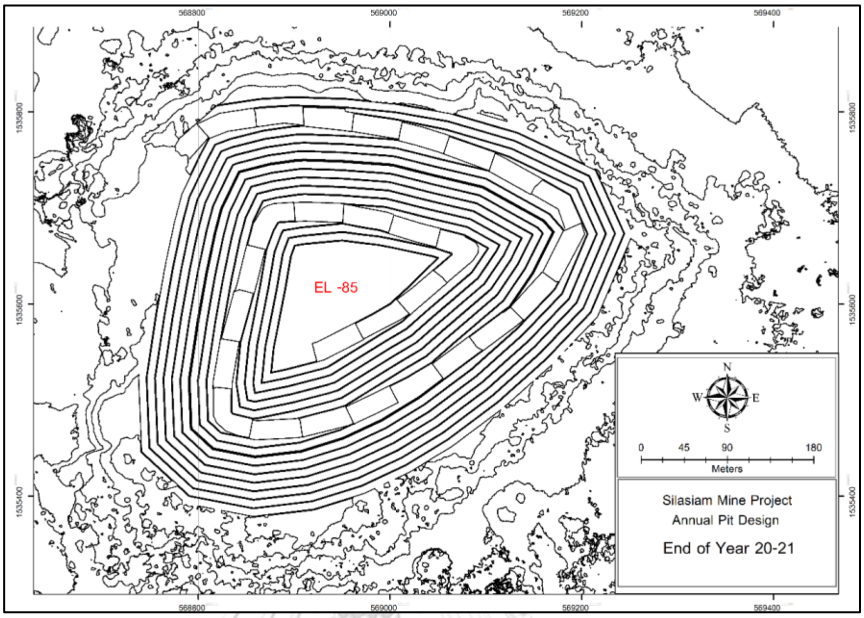

Figure 4.8 Annual open pit plan - End of year 21

End of year 21 is the last year of mine planning. The mined operated at this period is at elevation of -85 which achieved material of 1.05 million tons. The cumulative production of granite rock from year 1 to 21 is approximately 48.48 million tons.

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4.2 Mine equipment productivity calculation

4.2.1 Summarize

Equipment productivity was calculated based on a per-shift basis considering the project material and operating conditions. Availability and utilization were applied to determine the required number of operating units. Haul truck productivity was based on detailed haul time simulations in accordance with measured truck capacity by time period, from each phase of the pit and crushing plant location destination.

The mining equipment using in this project consisted of three major unit equipment such as blasthole drilling equipment for breakage material into smaller size, hydraulic excavator uses for loading the blasting material to hauling truck and transport material from the pit to crushing plant or stockpile.

In this study the mine major equipment summarized in Table 10. the mine production planning required to move 2.4 million ton per year (1,000 tons per hour) of granite rock from pit to crushing plant. Units productivity calculation showed in Table 13, 16 that the drilling speed of blast hole drills is 0.5 hour per hole, excavator productivity of 529 tons per hour, hauling truck productivity of 181 tons per hour per unit. So, we could conclude that the major mining equipment required of 2 units of blast-hole drills equipment, 2 units of excavator, and 6 units of hauling truck.

Table 10 Mine major equipment required

Major mine equipment	Qty (unit)
Blasthole drilling machine (Caterpillar MD5050)	2
Hydraulic excavator (Caterpillar 349D)	2
Hualing truck (Caterpillar 773E)	6

4.2.2 Mine working time

Mine operation is scheduled for 365 days per year and one shift per day of 8 hours duration. 65 days per year assumed to be lost due to public holidays, weekends, and mine shutdown. Mine schedule working hours summarized in Table 11. A working 6 days on and 1 day off has been used when calculating mine equipment operators and maintenance personnel (Michael Noakes & Lanz, 1993).

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Table 11 Mine operation schedule

Parameters lost	Parmeters value
Calendar day	**365**
Less, public holiday	12
weekends	48
Mine shutdowns	5
Scheduled Days	**300**
Shift Length (Hour)	8
Shift per Day	1
Scheduled Hours	**2,400**
Less, routine services	48
major overhauls	48
breakdown maintenance	72
Total Maintenance	168
Avialable Hours	**2,232**
Less, weather outages	-
no operator	50
meal break, shift change	-
industrial, other	-
Total Idel Hours	50
Operating Hours	2,182
Less, Fuel/lube	4
bit change	-
await blast	24
waiting, other	-
Total Delay Hours	28
Work Hours	**2,154**
Efficiency	**90%**

4.2.3 Drilling and blasting

Drilling is planned to be accomplished with conventional track mounted rotary blast-hole drills. Drills were selected based on the physical characteristics of the mineral and the production requirement. Caterpillar MD505 track drills of 250 cfm, 63.5 mm – 102 mm (2.5in – 4.0 in) bit diameter with a hole depth maximum of 31 meters was selected in this study (Handbook., 2012). Basting design is based on Dyno Nobel (Nobel & Group, 2010).

Table 12 Blasting parameters

Parameters	Relationship	Parameters Value	
Hole diameter (D)		102.00	mm
Burden (B)	B = (25 to 40) x D	3.57	m
Specing (S)	S = 1.25B	4.46	m
Sub-drilling (SD)	SD = (3 to 15) x D	1.02	m
Stemming length (SL)	SL = (0.7-1.3) x B	3.00	m
Bench height	BH	10.00	m
Hole length (L)	L = BH + SD	11.02	m
Charge length (C)	C = L - SL	8.02	m
Explosive density		1.20	ton/m3
Granite density		2.50	ton/m3
Blast Volume (V)	V = B x S x BH	159.31	m3
Blast tonnes (T)	T = V x Density of rock	398.28	Ton
Volume of blasthole	$= (\pi \times D^2 / 4000) \times C$	0.07	m3
Mass of explosive per hole		78.7	kg

4.2.4 Hydraulic excavator productivity calculation

Hydraulic excavators are widespread and versatile types of heavy equipment. The main use of excavators in mining project is to load blasting rock from pit to hauling truck. Caterpillar 349F was chosen over wheel loaders for economic reasons and maneuverability in this project. Hydraulic excavator is also well suited for certain sites and has a wider range of movement.

The productivity of hydraulic excavator is a digging cycle, which divided into four segments:

1) Load the bucket time required
2) Swing loaded bucket time required
3) Dump the bucket time
4) Time to swing with empty bucket

Cycle time in this depends on job condition and machine size. For example, a large excavator usually cycles slower than a small one, but it will handle.

Table 13 Caterpillar 349F productivity estimation

Parameter	Value	Unit
BC (bucket size)	3	m3
BF (bucket fill factor)	80	%
D (density in place)	2.5	kg/m3
MA (mechanical availability)	90	%
JF (job factor)	80	%
SF (swell factor)	75	%
1 pass loading time (CT)	16.8	Sec
O (productivity) = $\frac{BC \times BF \times D \times MA \times JF \times 3{,}600}{(1+SF) \times CT}$	**529**	ton/hr

4.2.5 Hauling truck productivity calculation

Haul truck plays a significant role in mining industries of moving material from the pit to crushing plant or stockpile. It is essential to comprehend the different characteristics of trucks in order to manage costs and enhance productivity. In general, time of truck productivity spent divided into three periods such as (1) excavating and loading material to truck, (2) transporting material from the pit to crushing plant or stockpile, and (3) returning from dumping to the pit or loading point again. It is called cycle time. Cycle time is a sensitive operation unit consisted of loading, hauling, dumping, returning, and spotting. The assumptions of dumping and spotting have been made based on Caterpillar Handbook information of 1.5 minutes and 0.8 minute (Caterpillar Handbook, 2008). Cycle time summaries in Table 14.

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Table 14 Hauling and returning distance estimates

Segment	Length(m)	Grade (%)	Avg.Speed (km/h)	Time (min)
Hauling				
Outside the pit to the plant	300	0	25	0.72
Inside the pit	1,400	10	16	5.25
Total in hualing	1,700			**5.97**
Returning				
Outside the pit to the plant	300	0	30	0.6
Inside the pit	1,400	-10	17.5	4.8
Total in returning	1,700			**5.4**

Hauling and returning time calculated based on the length of haulage road. It is defined into 2 segments under the road condition (percent grade) such as inside pit and outside pit of 1,400 meters and 300 meters respective.

Table 15 Cycle time estimaites

Parameter	time	Units
Loading time	3.5	mins
Hauling	6.0	mins
Dumping	1.3	mins
Returning	5.4	mins
Spotting	0.3	mins
Total cycle time	**16.4**	**mins**

In this study, Off-Highway trucks Caterpillar 773E of 55.5 tons nominal payload was chosen for hauling the material from pit to crushing plant. The productivity estimates of hauling truck presented on Table 16.

Table 16 Caterpillar 773E productivity estimation

Parameter	Value	Unit
Working time (1hour)	60	min
Operation efficiency	90%	%
Truck capacity	55.5	ton
Cycle time	16.4	min
$\boldsymbol{O}\ (productivity) = \frac{60 \times Operation\ efficiency \times truck\ capacity}{cycle\ time}$	**182**	ton/hr/unit

Other support equipment selected for the mining fleet include front end loader (Caterpillar 950G), Bulldozer, grader (Caterpillar 14E), fuel truck, water truck, pit dewater machine, and pickup.

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Table 17 Mine support equipments

Mine Support Equipment / Facilities	Qty (unit)
Front end loader (Cat 950G)	2
Bulldozer	1
Greader (Caterpillar 14 E)	1
Pickup	4
Fuel Truck	1
Water truck	1
Pit Dewatering machine (Pump@80m.H)	1
Engineer/Geology Equipment	1

4.3 Crushing plant

The purpose for design of crushing plant is to install to meet production requirement at a competitive cost of operation, complies with environmental regulations, and be built at a reasonable price.

Crushing plant was planned to process 365 days per year, and 2 shifts per day of 8 hours duration. 65 days per year assumed to be lost due to public holidays, weekends, and mine shutdown, total maintenance assume to be 100 hours. A working 6 days on and 1 day off has been used for crushing plant productivity calculation. Some unplanned downtime was assumed (Ken Boyd, 2003).

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Table 18 Crushing plant operating schedule

Production requirements - Typical		
1100*1200 mm primary crusher feed conveyour system Operaing schedule calculation		
Shift Length (Hour)	8	
Shift per day	2	
Days per year	365	
Days off per year (A working 6 days on and 1 day	48	
Tonnes per year	2,400,000	
Metric tonnes per day	8,000	
Total time available	5,072	hours per year
Unplanned downtime		
(Subract planned or know downtimes)		
Industrial	-	
Electrical - grid	24	
Weather	48	
Holidays	-	
Major scheduled maintenance	**313**	1 x 8 hr maintenance shift / wk
Crusher maintenance	78	1 convave chang box 1, 2 months change 24 x 2
Minor scheduled maintenance	-	
Shift changes	53	10 minuts/shift
Total Lost time	516	
Production Time	**4,557**	Hours per year
(Time system is available)		
System availability percentage	90%	Production time / total time
Unplanned downtime		
(Subtract unplanned downtimes)		
No ore	228	5% of productjion time (8 hrs/wk no truck delivering ore or other reasons)
Crusher plug	91	2% of production time
Chute plug	114	2.5% of prodcution time
Stockpile full	46	1% of prodcution time
Safety switch	114	2.5% of prodcution time
Metal on belt	48	Approx. 1 hr/wk
Belt repair	137	3% of prodcution time
Electrical	114	2.5% of prodcution time
Mechanical repair	114	2.5% of prodcution time
Others	0	
Subtract Unplanned Downtimes Hours	**1,005**	
Run Time (Operating Time)	3,552	
Total yearly downtime	1,520	
System utilization %	70	
Average hours per shift	5.60	
2 shifts, hours	11.20	

The crushing plant designation based on the characteristic of granite rock and mine plan. The important elements of aggregate processing system consisted of crusher equipment, screen, belt conveyor, and dust collector. The flow chart of the crushing plant is provided in Figure 4.9 showing crusher circuits. Screening is to separate of aggregate particle into various sizes and aggregate transport by belt conveyer. Dust

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collector equipment used for collecting the dust generated at the vibration screen and crushing machine locations.

Jaw crusher as primary crusher, capacity of 600 tons per hour, takes the mined material, close size setting is at 210 mm and reduction ratios of up to about 6:1. Cone crushers, secondary and tertiary crusher, take the material from a jaw crusher for further reduction. The close size setting is set as 51 with While cone crushers can reduce material size up to a maximum of 8:1 ratio. While the primary feeder used vibrating grizzly feeders, and the secondary feeders used vibrating screen. There are various sizes of screening equipment used in accordance with the appropriate size from 63 mm to 4.75mm, whereas the belt conveyor is set into 17 degrees under the angle of repose of material condition. The finish aggregate product consisted of 0-4 mm, 4.75-9.5 mm, 9.5-12.5 mm, 12.5-25 mm and 25-63 mm. The crushing plat design and price based on the SBM quotation presented in Appendix B.

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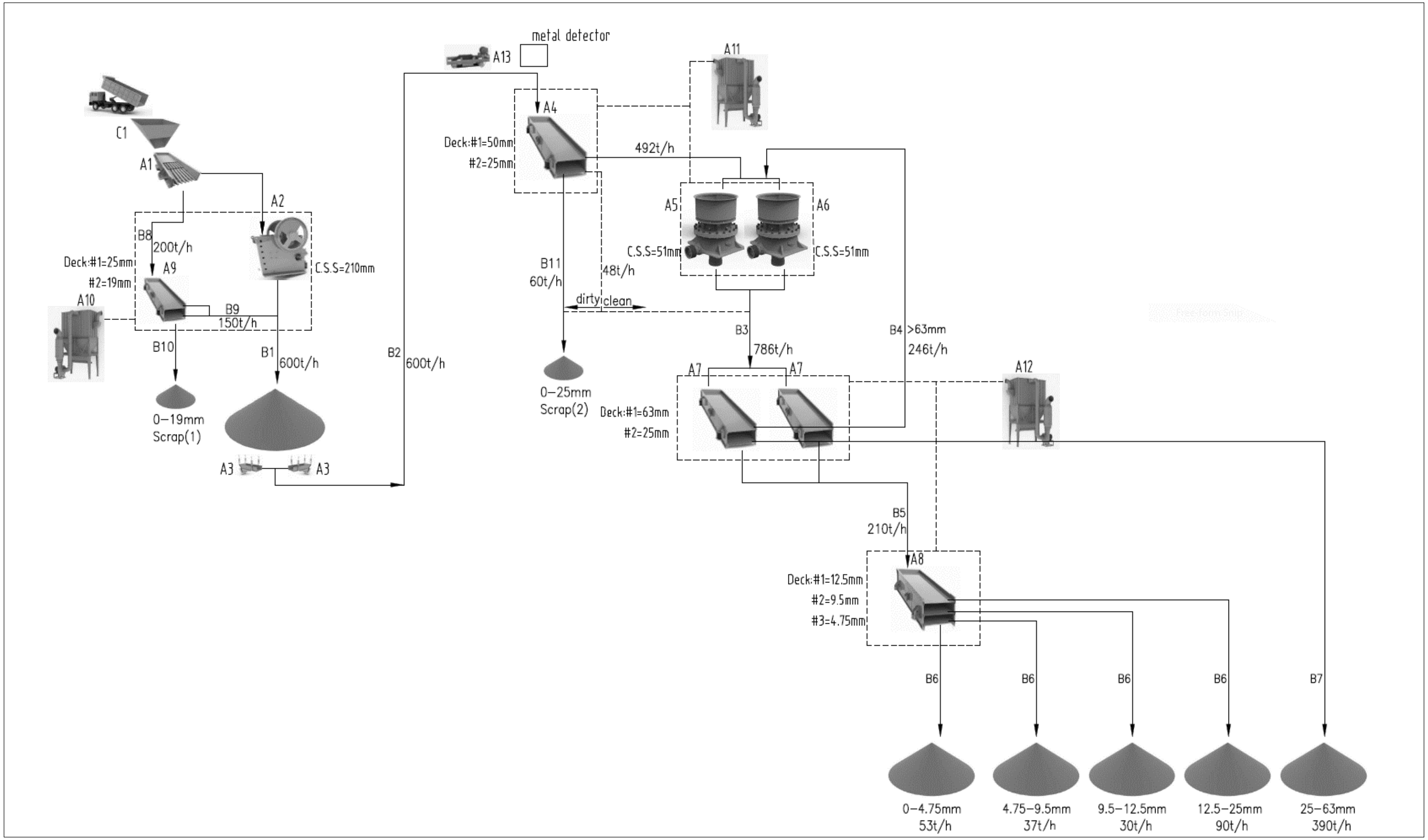

Figure 4.9 Flow chart of crushing plant circuits

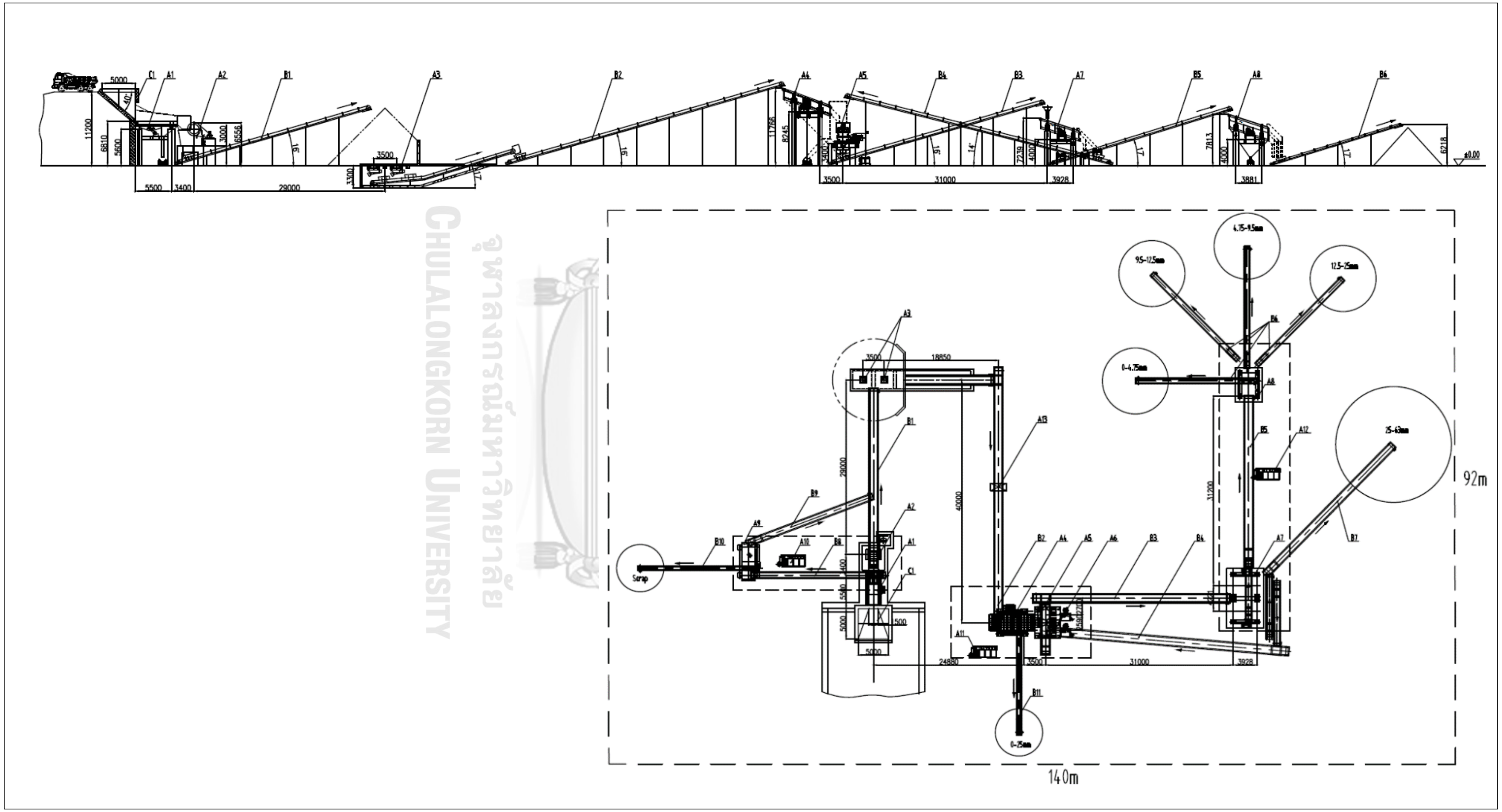

Figure 4.10 Layout of crushing plant line

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Table 19 Major crushing equipment list[1]

No	Item	Model	Description	Qty	Power (kW)
A1	Vibrating feeder	F5X1360	Max feed 900 mm, max capacity 600 t/hr, side of funnel 1,300x600 mm, inclination 5 degree, overall dimension (L*W*H) 6195x1960x1682 mm	1	30
A2	Jaw crusher	PEW1100	feed opening 1,100*1,200 m, max feeding size 930 adjustable range of discharge opening 150-275 mm, Capacity 300-650 t/hr, rotation speed of shaft 210 r/min, overall dimension 4140x2660x3560 mm	1	185
A3	Vibrating feeder	ZSW200*120	Max feed 300 mm, capacity 80-500 t/hr, size of funnel 2000*1200, overall dimension 2000x1200x855 mm	2	2.2x2
A4	Vibrating feeder	S5X2760-2	Specification of screen 2700*6000, 2 layers, sieve pore size 2-70 mm, capacity 120-900 t/hr, overall dimension 6223x4550x3469 mm	1	30
A5	Cone crusher	GST250(S2)	Max feeding size 400mm, min discharging 29m, capacity 215-515 t/h, overall dimension 2100x2320x4096	1	220
A6	Cone crusher	HST259(S3)	Max feeding size 400mm, min discharging 29m, capacity 215-515 t/h, overall dimension 2100x2320x4096	1	220
A7	Vibrating screen	S5X2760-2	Specification of screen 2100x6000, 2 layers, sieve pore size 2-70 mm, capacity 85-700 t/hr, overall dimension 6223x3907x3437	2	30
A8	Vibrating screen	S5X2160-3	Specification of screen 2100x6000, 3 layers, sieve pore size 2-70 mm, capacity 85-700 t/hr, overall dimension 6223x3948x4016	1	30
A9	Vibrating screen	S5X2160-2	Specification of screen 2100x6000, 2 layers, sieve pore size 2-70 mm, capacity 85-700 t/hr, overall dimension 6223x3907x3437	1	22
B1	Belt conveyor	B1200-30m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
B2	Belt conveyor	B1200-22/43m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
B3	Belt conveyor	B1400-12/33m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
B4	Belt conveyor	B1000-10/41m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
B5	Belt conveyor	B1000-10/28m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
B6	Belt conveyor	B650-20m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	4	-
B7	Belt conveyor	B1000-10/30m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
B8	Belt conveyor	B800-22m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
B9	Belt conveyor	B800-22m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
B10	Belt conveyor	B500-20m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
B11	Belt conveyor	B500-20m	Angle 0-17 degree, belt speed 1.0-2.0m/s. ca[acotu 100-800 t/hr	1	-
C1	Hopper	LC6x6m		1	-
A10	Dust collector	ZXMC-160-2.5	Filtering wind speed 2.3-2.5 m/min, filter area 160m2, airflow 22080-24000 m3/hr, full presure 2448-2127 Pa	1	22
A11	Dust collector	ZXMC-260-2.5	Filtering wind speed 2.3-2.5 m/min, filter area 260m2, airflow 35880-40560m3/hr, full presure 2902-26294 Pa	1	45
A12	Dust collector	ZXMC-380-2.5	Filtering wind speed 2.3-2.5 m/min, filter area 380m2, airflow 52440-57000m3/hr, full presure 3319-3164 Pa	1	75
A13	Magnetic separator	RCYC-12	Applicabel belt width 1200mm, rated suspension height 350mm, intensity (at RSH) >70 Gs, excitation power <4 Kw	1	4

[1] SBM Quotation

4.4 Capital cost and operating cost

4.4.1 Capital cost

4.4.1.1 Summarize

The estimated capital cost or capital expenditure (CAPEX) for this study consisted of: (1) the initial CAPEX to design, permit, construct the mine, plant facility, and operations camp; (2) the sustaining CAPEX for facilities expansions mining equipment replacements; (3) the closure and rehabilitation components of the project; (4) working capital to cover delays in the receipts from sales and payments for accounts payable.

Table 20 summarizes the initial, sustaining and closure CAPEX for the project. it includes direct mining equipment, crushing plant costs, on-site infrastructure such as operation camp, and off-site infrastructure such as the power line, the mine access road, and reclamation and closure costs. The CAPEX also includes indirect costs for engineering, permitting, land acquisitions, and other costs. Indirect cost was estimated by 40% of processing cost and on-site infrastructure (Ken Boyd, 2003)

Table 20 Summary of Capital costs

Capital Cost Area	Detail	Initial CAPEX	Sustaining CAPEX	Closure CAPEX	Total CAPEX
Direct Costs	Mine Cost	฿ 201,581,000	฿ 161,400,000	-	฿ 362,981,000
	Crushing Plant	฿ 63,929,058	฿ 63,929,058	-	฿ 127,858,116
	On-Site Infrastructure	฿ 23,850,000	-	-	฿ 23,850,000
Indirect Cost		฿ 26,333,717	-	-	฿ 26,333,717
Closure and reclamation Costs		-	-	฿ 12,336,321	฿ 12,336,321
License acquisition		฿ 8,750,000	-	-	฿ 8,750,000
Working Capital		฿ 11,370,750	-	-	฿ 11,370,750
Contingency		฿ 25,440,385	-	-	฿ 25,440,385
Total CAPEX with Contingency		**฿361,254,911**	**฿ 225,329,058**	**฿ 12,336,321**	**฿ 598,920,290**

4.4.1.2 Mine capital cost

Mine capital costs include (1) capital to purchase the major mining equipment consisted of two unit of blasthole drills equipment (Caterpillar MD5050), two units of hydraulic excavator (Caterpillar 349F), and six units of off-high way truck (Caterpillar 772E), (2) capital for mine support equipment comprised of two units of front end loader (Caterpillar 950G), bulldozer, grader, fuel truck, water truck, pick up, pit dewatering machine (Pump@80m.H) and others. Mine major and support equipment

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used was based on the estimate at Table 10 and 17. Mine capital cost include sustaining are presented in Table 21.

Table 21 Mine capital cost summary

Mine CAPEX Components	Pre-Production	Sustaining	Total CAPEX
Mine Major Equipment	฿ 157,000,000	฿ 143,000,000	฿ 300,000,000
Mine Support Equipment	฿ 44,581,000	฿ 18,400,000	฿ 62,981,000
Total mine capital costs	**฿ 201,581,000**	**฿ 161,400,000**	**฿ 362,981,000**

Table 22 summarizes the mine capital costs. the buyout costs for the mining equipment are included as initial capital and sustaining cost. Mine major equipment and mine support equipment pricing were priced from Silasiam mine database and vendor quotes for capital equipment purchases.

Table 22 Mine major equipment cost

Mine Mojor Equipment	Qty (unit)	Cost/unit	Pre-Production	Sustaining	Total CAPEX
Blasthole drills (Caterpillar MD5050)	2	฿ 14,000,000	฿ 28,000,000	฿ 14,000,000	฿ 42,000,000
Hydraulic excavator (Caterpillar 349F)	2	฿ 10,500,000	฿ 21,000,000	฿ 21,000,000	฿ 42,000,000
Caterpillar 772E	6	฿ 18,000,000	฿ 108,000,000	฿ 108,000,000	฿ 216,000,000
Total Mining Mojor Equipment Cost			**฿ 157,000,000**	**฿ 143,000,000**	**฿ 300,000,000**

Mine support equipment will be purchased outright. Table 23 presented the mine support equipment capital costs. The shop tool and initial spare parts are estimated 3% and 5% of mine major equipment respectively.

Table 23 Mine support equipment and facilities capital costs

Mine Support Equipment / Facilities	Qty (unit)	Cost/unit	Pre-Production	Sustaining	Total CAPEX
Front end loader (Cat 950G)	2	฿ 7,500,000	฿ 15,000,000	฿ 7,500,000	฿ 22,500,000
Bulldozer	1	฿ 9,700,000	฿ 9,700,000	฿ 9,700,000	฿ 19,400,000
Greader (Caterpillar 14 E)	1	฿ 1,200,000	฿ 1,200,000	฿ 1,200,000	฿ 2,400,000
Pickup	4	฿ 1,000,000	฿ 4,000,000	฿ -	฿ 4,000,000
Fuel Truck	1	฿ 651,000	฿ 651,000	฿ -	฿ 651,000
Water truck	1	฿ 420,000	฿ 420,000	฿ -	฿ 420,000
Pit Dewatering machine (Pump@80m.H)	1	฿ 1,000,000	฿ 1,000,000	฿ -	฿ 1,000,000
Engineer/Geology Equipment	1	฿ 50,000	฿ 50,000	฿ -	฿ 50,000
Shop Tools (3% of Major Equipment)	1	฿ 4,710,000	฿ 4,710,000	฿ -	฿ 4,710,000
Initial Spare Parts (5% of Major Equipment)	1	฿ 7,850,000	฿ 7,850,000	฿ -	฿ 7,850,000
Total mine support equipment cost			**฿ 44,581,000**	**฿ 18,400,000**	**฿ 62,981,000**

4.4.1.3 Crushing plant capital costs

Capital costs for the crushing plant estimate from quotations of vendors, consultants, and estimates based on experience with similar projects of this type under the cost of equipment, material, labor, and construction equipment need to complete the plant to start-up. The capital estimate for crushing plant is presented in Table 24.

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Table 24 Crushing plant capital cost

Area Description	Model	Qty	Pre-Production	Sustaining	Total CAPEX
Moter		1	฿ 1,289,300	฿ 1,289,300	฿ 2,578,600
Control system		1	฿ 3,500,000	฿ 3,500,000	฿ 7,000,000
Weighing machine (60-80 ton + installation)		1	฿ 11,110,000	฿ 11,110,000	฿ 22,220,000
Vibrating feeder	F5X1360	1	฿ 1,541,640	฿ 1,541,640	฿ 3,083,280
Jaw crusher	PEW1100	1	฿ 7,272,750	฿ 7,272,750	฿ 14,545,500
Vibrating feeder	ZSW200x120	2	฿ 191,250	฿ 191,250	฿ 382,500
Vibrating feeder	S5X2760-2	1	฿ 1,692,750	฿ 1,692,750	฿ 3,385,500
Cone crusher	GST250(S2)	1	฿ 8,917,890	฿ 8,917,890	฿ 17,835,780
Cone crusher	HST259(S3)	1	฿ 8,917,890	฿ 8,917,890	฿ 17,835,780
Vibrating screen	S5X2760-2	2	฿ 1,692,750	฿ 1,692,750	฿ 3,385,500
Vibrating screen	S5X2160-3	1	฿ 1,627,890	฿ 1,627,890	฿ 3,255,780
Vibrating screen	S5X2160-2	1	฿ 1,281,750	฿ 1,281,750	฿ 2,563,500
Belt conveyor	B1200-30m	1	฿ 797,250	฿ 797,250	฿ 1,594,500
Belt conveyor	B1200-22/43m	1	฿ 1,701,750	฿ 1,701,750	฿ 3,403,500
Belt conveyor	B1400-12/33m	1	฿ 1,537,500	฿ 1,537,500	฿ 3,075,000
Belt conveyor	B1000-10/41m	1	฿ 1,171,140	฿ 1,171,140	฿ 2,342,280
Belt conveyor	B1000-10/28m	1	฿ 937,890	฿ 937,890	฿ 1,875,780
Belt conveyor	B650-20m	4	฿ 306,750	฿ 306,750	฿ 613,500
Belt conveyor	B1000-10/30m	1	฿ 973,890	฿ 973,890	฿ 1,947,780
Belt conveyor	B800-22m	1	฿ 415,500	฿ 415,500	฿ 831,000
Belt conveyor	B800-22m	1	฿ 415,500	฿ 415,500	฿ 831,000
Belt conveyor	B500-20m	1	฿ 279,750	฿ 279,750	฿ 559,500
Belt conveyor	B500-20m	1	฿ 279,750	฿ 279,750	฿ 559,500
Hopper	LC6×6m	1	฿ 17,950	฿ 17,950	฿ 35,900
Dust collector	ZXMC-160-2.5	1	฿ 1,152,053	฿ 1,152,053	฿ 2,304,106
Dust collector	ZXMC-260-2.5	1	฿ 1,872,400	฿ 1,872,400	฿ 3,744,800
Dust collector	ZXMC-380-2.5	1	฿ 2,736,525	฿ 2,736,525	฿ 5,473,050
Magnetic separator	RCYC-12	1	฿ 297,600	฿ 297,600	฿ 595,200
Total Crushing Plant Capital cost			**฿ 63,929,058**	**฿ 63,929,058**	**฿ 127,858,116**

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4.4.1.4 Infrastructure costs

The on-site infrastructure consisted of site utilities and roads, auxiliary facilities, and the operation camp. Table 25 summarizes the costs for infrastructure. The cost of construction of administration building, warehouse, fuel station, explosive storage is 8,000 baht/m^2, permanent camp estimates to be 7,300 baht/m^2, and truck shop, truck warehouse, plant maintenance building is 17,300 baht/m^2. The costs for infrastructure is based on the construction cost of Thailand ("Construction cost in Thailand," 2019).

Table 25 Infrastructure capital costs

Area Description	Area (sqm)	Bath/sqm	Total
Administration Building	400	฿ 8,000	฿ 3,200,000
Warehouse	50	฿ 8,000	฿ 400,000
Truck Shop/ Truck Wash /Truck Warehouse	400	฿ 17,300	฿ 6,920,000
Plant Maintenance Building	400	฿ 17,300	฿ 6,920,000
Permanent camp	500	฿ 7,300	฿ 3,650,000
Fuel Station	30	฿ 8,000	฿ 240,000
Explosives Storage	65	฿ 8,000	฿ 520,000
Funiture			฿ 2,000,000
Total Infrastructure capital cost			**฿ 23,850,000**

4.4.1.5 Mine closure and reclamation costs

Reclamation is planned to plant the tree along the surface, bench, road area, and developing the pit as the water reservoir after end of operation period. Closure costs include items as potential long-term water reservoir monitoring, reclamation maintenance activities, and site monitoring.

Table 26 Closure and reclamation cost

Item	Baht/unit	Qty	LOM
Tree planting	10	5,460	฿ 54,596
Fertilizer (kg)	15	32,758	฿ 7,881,725
Equipement	10,000	1	฿ 2,400,000
Other	20,000	1	฿ 2,000,000
Total closure cost			**฿ 12,336,321**

4.4.1.6 Contingency

Contingency costs, as summarized in Table 27, are estimates of the costs that can be expected to be spent during construction. The contingency estimated from the project is 17.5% of the crushing plant, infrastructure and 5% of mine capital. The contingency cost is based on prefeasibility study report of stibnite gold mine ("Prefeasibility Study Technical Report of Stibnite Gold Project," 2014).

Table 27 Contingency capital cost

Contingency Capital Costs	Percentage	Cost (Baht)
Mine Capital	5.0%	฿ 10,079,050
Crusing plant	17.5%	฿ 11,187,585
Infrastructure	17.5%	฿ 4,173,750
Total Contingency Cost		**฿ 25,440,385**

4.4.2 Operating cost

4.4.2.1 Summarize

The average cash operating cost before royalties and transportation charge over the life of mine estimated to be 59.22 baht per ton. These cash operating cost include mine operation, crushing operation, and general and administrative costs (G&A). Table 28 presented OPEX estimation.

Table 28 OPEX Summary

Operating cost item	Average cash operating cost (Baht/ton)
Mining OPEX	฿ 31.63
Crushing OPEX	฿ 24.32
General & Adminstrative OPEX	฿ 3.27
Average Cash Operating Cost	**฿ 59.22**

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Major cost items driving the OPEX estimate include power (diesel and electricity) and labor. The detail comprises of OPEX provided in the section below.

4.4.2.2 Fuel and electricity price

Table 29 presented the unit costs for the major consumption of the project (diesel fuel and power)

Table 29 price assumptions for power

Item	Unit	Cost Estimate	Comment
Electricity	Baht/kWhr	4.00	Quote for off-road to site
Diesel fuel	Baht/liter	25.00	Price rate quote

4.4.2.3 Labor Requirements

Labor for the project was estimated from the mining operator, crushing plant operator, and general and administrative (G&A) support. The rate of labors was estimated using market surveys for the region and wage rates from other mining operation in the area. Working one shift per day for mining operating and two shifts per day for crushing plant operating in 6 day on, 1 day off work schedule. Table 30 shown the average monthly estimated payroll.

Table 30 Estimated labor requirements

Labor category	Number of personal			Average annual payroll
	Low	Peak	Average	
Mine Operation	28	53	33	฿ 7,644,000
Mine maintenance	3	6	4	฿ 936,000
Crushing plant operation	20	41	31	฿ 6,656,000
Crushing plant maintenance	5	11	8	฿ 1,872,000
General and administrative	13	22	19	฿ 4,881,500
Totals labors	69	133	95	฿ 21,989,500

4.4.2.4 Mine operating cost

Mine operating costs were estimates based on mine plan and major mine and support equipment requires. The consumable and labor operating costs by the unit operations summarized in Table 31. Mining OPEX cost calculation based on cost estimation handbook (Michael Noakes & Lanz, 1993).

Table 31 Mining operating cost averages

Mining Function	percentage	Cost (Baht/ton)
Drilling	10.02%	3.17
Blasting	14.86%	4.70
Loading	11.45%	3.62
Hualing	44.19%	13.98
G&A	11.30%	3.58
Mine support	8.17%	2.59
Total mining OPEX cost		฿ 31.63

Drilling, blasting, loading, and hauling of the material from the pit to crushing plant or stockpiles, maintenance of mobile equipment is included in the mining operating cost. Mine supervision Mining engineering, geology included in the G&A category. Detail of Mining cost calculation provided in Appendix C.

4.4.2.5 Crushing plant operating cost

The crushing plant operating costs are summarized in Table 32. the operating cost for crushing included electric power, labors, maintenance parts and services. Detail of the crushing cost presented in Appendix C. Crushing plant cost estimate based on cost estimation handbook (Michael Noakes & Lanz, 1993).

Table 32 processing operating cost average

Crushing Function	Percentage	Baht/ton
Electrical cost	34.37%	฿ 8.36
Maintenance cost	44.21%	฿ 10.75
Laborers	21.43%	฿ 5.21
Total crushing OPEX cost		**฿ 24.32**

4.4.2.6 General and administrative operating cost

General and administrative costs consisted of accounting, sale, marketing, environmental and safety, community relations, training and other costs which not associated to mining and processing cost. G&A cost presented in Table 33.

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Table 33 General and administrative operating cost average

Employee	No. of person	Personnal salary	Baht/month
Accountant	3	฿ 20,000	฿ 60,000
Sales	4	฿ 18,000	฿ 72,000
Marketing	2	฿ 18,000	฿ 36,000
Enviroment	3	฿ 20,000	฿ 60,000
Coummunity relations	3	฿ 20,000	฿ 60,000
Generl officer	8	฿ 10,000	฿ 80,000
Housekeeper	3	฿ 9,000	฿ 27,000
Office consumable per capita	95	1,550	147,250
Other	-	-	44,150
Total general and adminstrative cost		baht/year	7,857,200
		baht/ton	**3.27**

4.5 Financial analysis

In this study, the economic analysis uses a financial model that estimates cash flows on an annual for the life of the project at the pre-feasibility level of engineering and design. The project annual cash flow over the life of mine is estimated based on the CAPEX, OPEX, sale revenue and other cost estimation. CAPEX estimated in categories of initial capital cost, sustaining capital cost, closure and reclamation, and working capital which distributed in accordance with year of expenditure. OPEX estimated consisted of mining cost, crushing cost, labor, maintenance, electrical power, and other cost for each year. The sale revenue estimated based on the product by the process, and other cost such as, royalties, taxes, and depreciation estimated in accordance with law of Thailand.

The financial cash flow model results are presented in terms of net present value (NPV), modified internal rate of return (MIRR), and payback period. Project annual cash flow over the life of mine are estimated based on the estimated of capital cost, operating cost and sale revenue.

4.5.1 Assumption

The project economic analysis is based on the following assumption.

- Aggregate price is fixed at 330 baht per ton. Price escalation is not considered during the period of assessment. 100 percent of product recovery.
- Funding for the project is assumed to be 80 percent equity and 20 percent loans. A discount rate of 14.3 percent applied to NPV calculations.
- An income tax of 30 percent is required to be paid from any mine operation. Every ton of granite aggregate produced, must be paid 8 baht to the government as royalty. Straight line depreciation of capital expenditure is applied. Equipment and crushing plant would be no salvage value at the end of the project.
- An operating mine is entitled to carrying forward the loss incurred in a particular year of assessment to the next year, except that the amount carried forward should not exceed the capital allowance (depreciation) in that year.

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4.5.2 Revenue

Revenue for the financial model is based on the production recovery of 100% and 2.4 Mton per year of feed from the mine plan. The aggregate price is fixed at120 baht/ton for fine aggregate and 330 baht/ton for 3/8”, ¾”, ½” and ballast aggregate.

Table 34 Granite aggregate price

Production item	% Recovery	Sale price (baht)	Sales per year (baht)
Fine aggregate	5%	฿ 120.00	฿ 14.40 M
3/8" aggregate	20%	฿ 330.00	฿ 158.40 M
3/4" Aggregate	20%	฿ 330.00	฿ 158.40 M
1/2" Aggregate	15%	฿ 330.00	฿ 118.80 M
Ballast Aggregate	40%	฿ 330.00	฿ 316.80 M
Total revenue per year			**฿ 766.80 M**

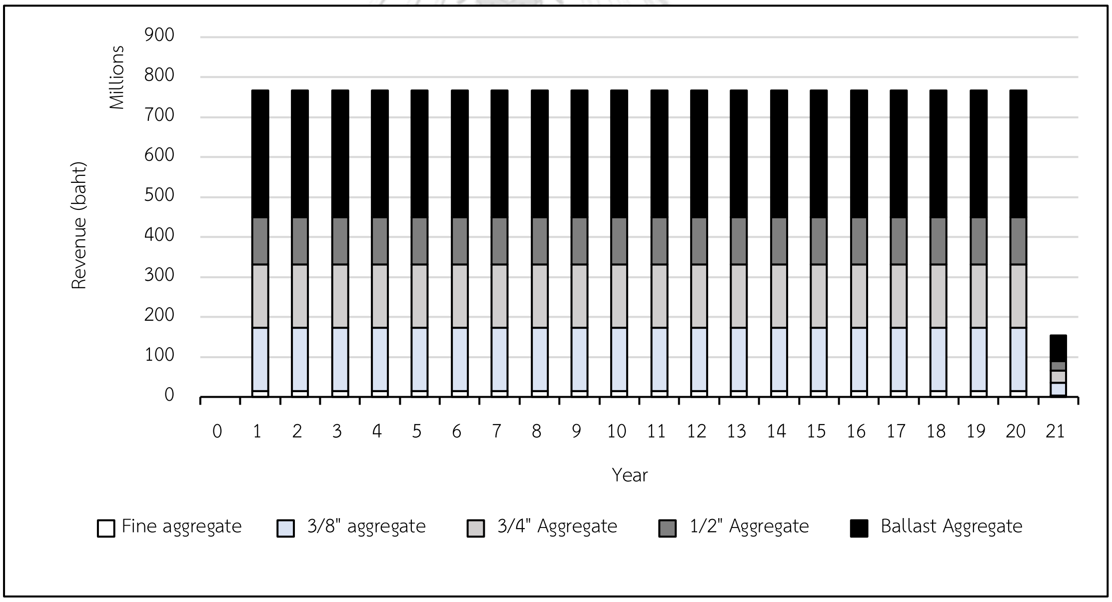

Figure 4.11 Annual revenue estimation

4.5.3 Royalties, depreciation and income tax

There are 8 baht per ton of finish products applied as a royalty fee on revenue. Royalty is deducted in revenue approximately 387.85 million baht over the life of mine. Depreciation calculation used a straight-line method taking off in the first year of production. And 30% of net operating income after deducted depreciation cost applied to taxable income.

Table 35 Royalty and Tax payable

Parameter	Average baht per year	LOM
Royalty	฿ 18.47 M	฿ 387.85 M
Tax	฿ 163.93 M	฿ 3,442.59 M

4.5.4 Weighted average cost of capital (WACC)

Funding of the project is assumed to be 80% equity and 20% loan. Cost of equity and cost is 15% and 10%. The discount rate estimates to be 13.4%.

Table 36 Weighted average cost of capital calculation

WACC Parameter	Parameter value
Market value of equity (baht)	฿ 479,623,621
Cost of equity (%)	15.00%
Market value of debt (baht)	฿ 119,905,905
Cost of debt (%)	10.00%
Tax rate (%)	30.00%
Weighted Average Cost of Capital (WACC)	**13.40%**

4.5.5 Financial model

The financial model shown in Table 37. The financial model presented in terms of NPV, MIRR and payback period on years for recovery of the capital costs. The economic indicators presented on both pre-tax and after-tax, and the NPV presented in undiscounted ($NPV_{0\%}$) and at a $NPV_{13.4\%}$ discount rate. The result indicated that the project after-tax deduction has an $NPV_{13.4\%}$ of 2,335 million baht, MIRR is 22.41%, and payback period of 1.6 year.

Table 37 Financial model result

Economic Indicators	Unit	Pre-tax Result	After-tax Result
NPV@0%	Million baht	11,403.41	7,960.82
NPV@13.4%	Million baht	3,509.51	2,335.94
MIRR	%	24.40%	22.41%
Payback period	Year	0.40	1.60

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Table 38 Financial model calculation

	Total 21	Year -	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Annual production	48,481,145	-	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000
Revenues	฿ 15,489.73 M	฿ .00 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M
Capital Cost	-฿ 598.92 M	-฿ 373.59 M										
Royalty	฿ 387.85 M	-	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M
Operating Cost												
Mining Cost	฿ 1,582.34 M	-	฿ 75.91 M	฿ 76.34 M	฿ 77.10 M	฿ 77.90 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M
Processing Cost	฿ 1,311.65 M	-	฿ 58.36 M	฿ 58.99 M	฿ 60.33 M	฿ 62.62 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M
G&A (+5% year 1-5)	฿ 217.89 M	-	฿ 7.86 M	฿ 9.55 M	฿ 9.93 M	฿ 10.33 M	฿ 10.75 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M
Total Operating Cost	฿ 3,111.89 M	-	฿ 142.13 M	฿ 144.88 M	฿ 147.37 M	฿ 150.85 M	฿ 155.72 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M
			฿ .00 M	฿ .00 M	฿ .00 M	฿ .00 M	฿ .00 M					
Net Operating Income	฿ 11,989.99 M	-	฿ 605.47 M	฿ 602.72 M	฿ 600.23 M	฿ 596.75 M	฿ 591.88 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M
Depreciation												
Construction	฿ 23.85 M	-	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M
Equipments	฿ 490.84 M	-	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M
Total Depreciation	฿ 514.69 M		฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M
Net Income after Depreciation	฿ 11,475.30 M	-	฿ 577.72 M	฿ 574.98 M	฿ 572.49 M	฿ 569.01 M	฿ 564.14 M	฿ 563.69 M	฿ 563.69 M	฿ 563.69 M	฿ 563.69 M	฿ 563.69 M
Tax (30%)	฿ 3,442.59 M	-	฿ 173.32 M	฿ 172.49 M	฿ 171.75 M	฿ 170.70 M	฿ 169.24 M	฿ 169.11 M	฿ 169.11 M	฿ 169.11 M	฿ 169.11 M	฿ 169.11 M
Net Profit After Tax	฿ 8,032.71 M	-	฿ 404.41 M	฿ 402.49 M	฿ 400.74 M	฿ 398.31 M	฿ 394.90 M	฿ 394.59 M	฿ 394.59 M	฿ 394.59 M	฿ 394.59 M	฿ 394.59 M
Add Deprciation	฿ 514.69 M	-	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M
Net Cash Flow after Tax		-฿ 598.92 M	฿ 432.15 M	฿ 430.23 M	฿ 428.49 M	฿ 426.05 M	฿ 422.64 M	฿ 422.33 M	฿ 422.33 M	฿ 422.33 M	฿ 422.33 M	฿ 422.33 M

		Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
Annual production	ton	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	481,145
Revenues		฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 153.73 M
Capital Cost		-฿ 225.33 M										
Royalty		฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 3.85 M
Operating Cost												
Mining Cost		฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 15.22 M
Processing Cost		฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 11.70 M
G&A (+5% year 1-5)		฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 1.58 M
Total Operating Cost		฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 28.49 M
Net Operating Income		฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 121.38 M
Depreciation												
Construction		฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ .00 M
Equipments		฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ .00 M
Total Depreciation		฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ .00 M
Net Income after Depreciation		฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 121.38 M
Tax (30%)		฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 36.41 M
Net Profit After Tax		฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 84.97 M
Add Deprciation		฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ .00 M
Net Cash Flow after Tax		฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 84.97 M

4.5.6 Life of mine

The current ore reserve, and production planning of 2.4 million tons per year shown that this mine would spend 21 years for operating. Construction and development of the project spent a one-year period after obtaining permission.

4.5.7 Sensitivity analysis

The sensitivity analysis of the financial model was tested under respect to CAPEX, OPEX, and aggregate price for each case. Each parameter values were raised and lowered from -30% to +30% to evaluate the effect of such changes on the NPV at an 13.4% discount rate. The result is presented in Fig 4.12. The aggregate price is the most sensitive value. For example, NPV increased by 47.38% when aggregate price rose up 30%. In other hand, when aggregate price dropped 30% changed NPV from 2,335 million baht into 1,229 million baht. Whereas, there is a small change in NPV when capital cost and operating cost up and down 30%.

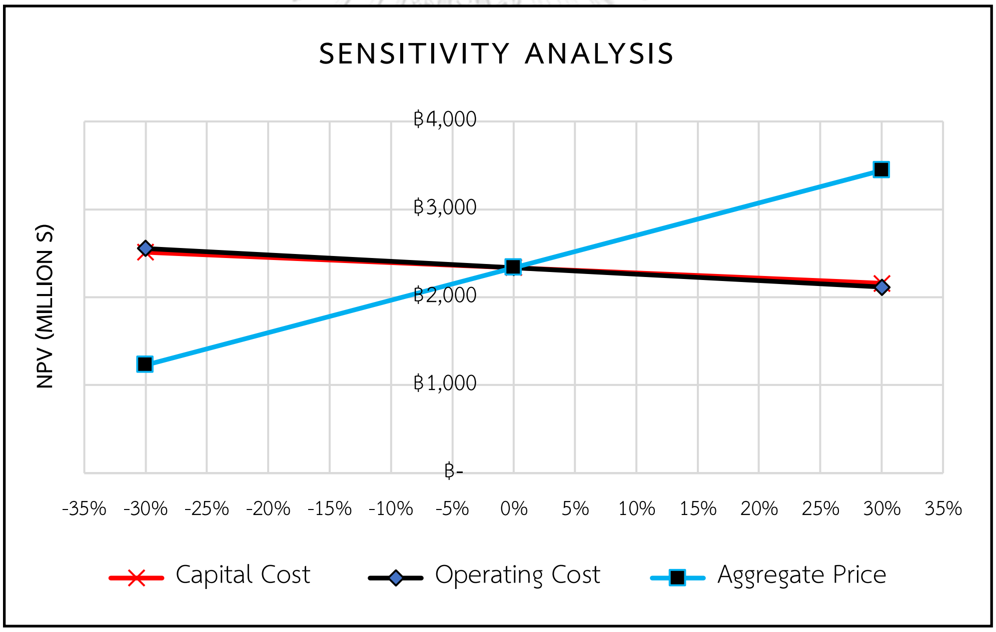

Figure 4.12 sensitivity analysis

4.6 Mine closure and reclamation

Rehabilitation and re-vegetation are an essential element of mine closure planning and commenced at mine plan stage. The post-mining land use for the mine area, and rehabilitation and re-vegetation would be agreed upon with local government, traditional landowners, and other interested parties. Post-closure activities would provide additional management until landform, vegetation, water quality, and social infrastructure are self-sustaining and meet the requirements of their users, or until management integrated into the surrounding area.

In this study, rehabilitation and re-vegetation occurring simultaneously with mining progress, and final rehabilitation efforts at the end of mine life would be minimal. Topsoil be restored, the fast-growing trees and native grasses are proposed to plant along the bench and the pit would be developed into a water reservoir. Mine closure activities and long-term monitoring are expected to continue, and also providing additional management until landform, vegetation, water quality, and social infrastructure meet agreed to targets and the regulatory approval process.

Referred to bench geometry 7 meters of bench width and 10 meters of bench height, the fast-growing trees are planted along the bench width. Fig 4.13 shown the re-vegetation. The distance between trees is 3 meters and 2 meters measuring from tree to toe and crest in the row direction, and 5 meters interval in columns direction. Fertilizer and inspection are offered within 3 years or more.

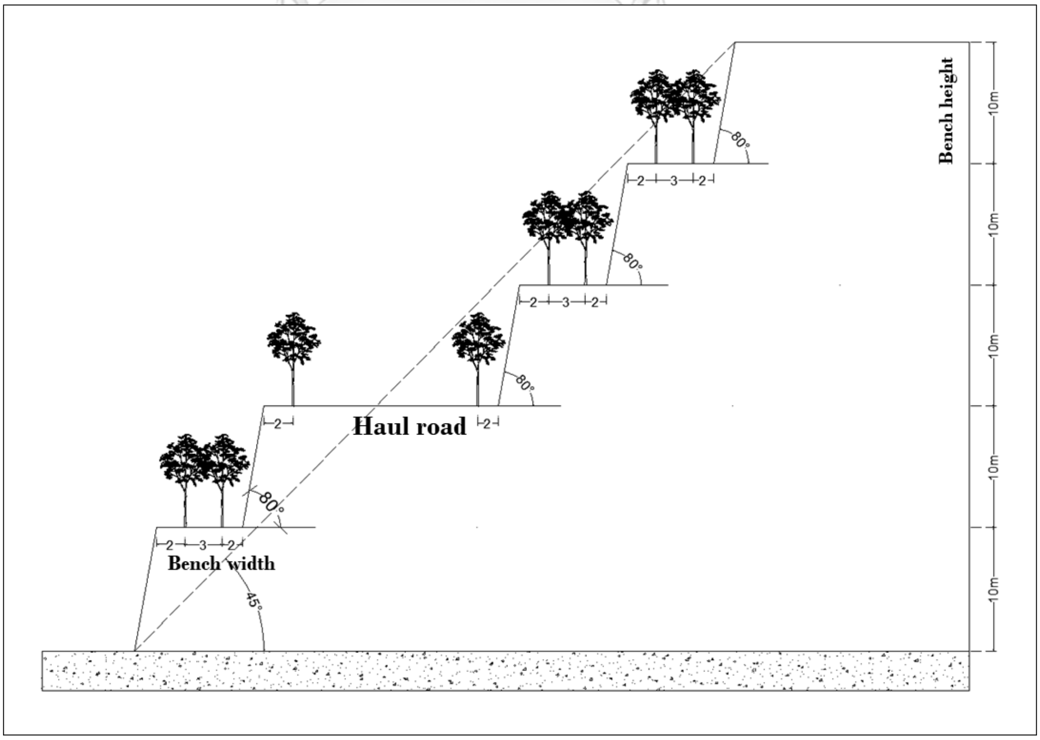

Figure 4.13 Fast-growing tree planting

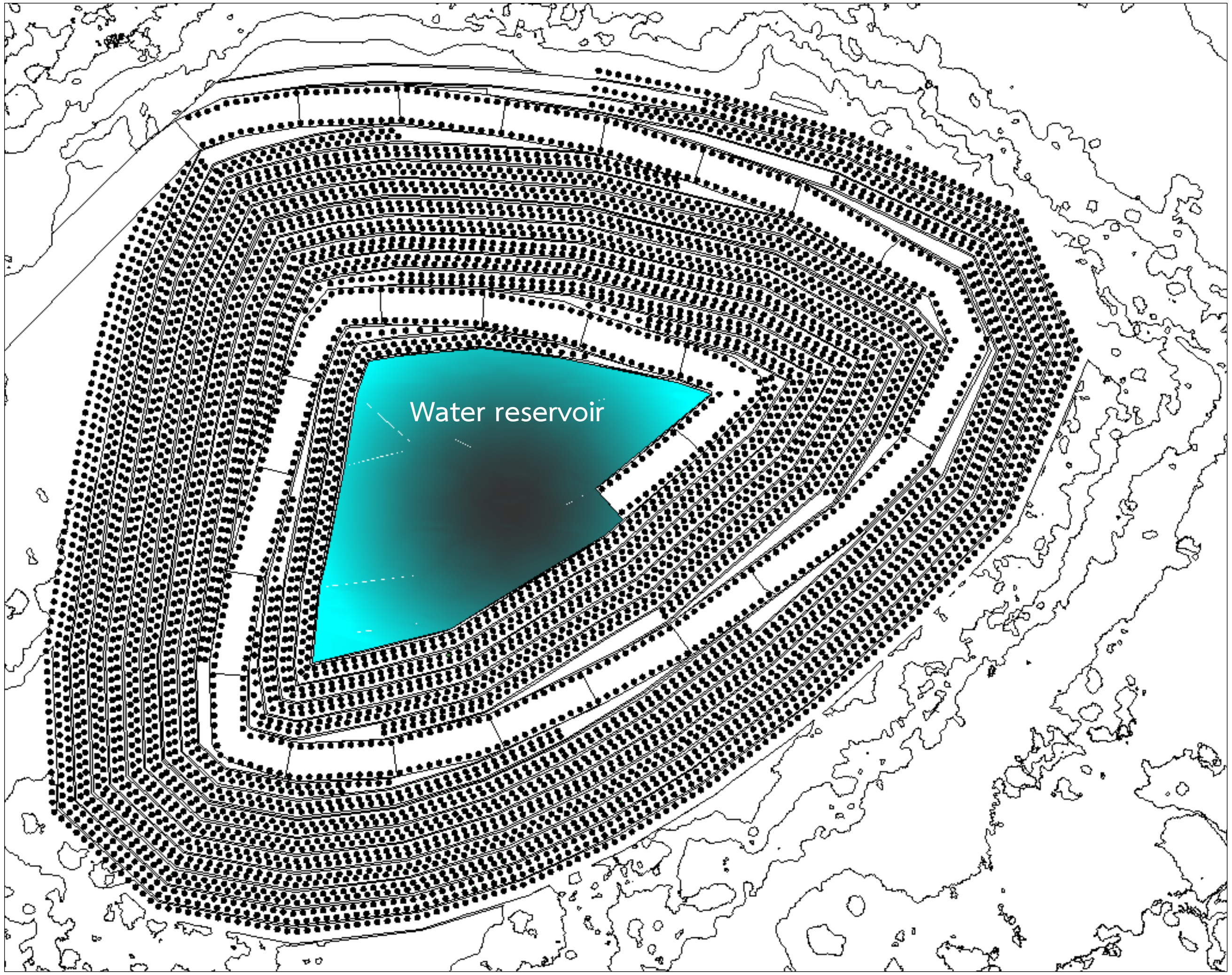

Figure 4.14 Mine reclamation planning

Chapter 5

Conclusions and recommendations

5.1 Conclusions

Preliminary Feasibility Study is a comprehensive study of a range of options for the technical and economic viability of a mineral project that has advanced to a stage. Financial analysis is based on reasonable assumptions on the modifying factors and the evaluation of any other relevant factors. However, a Preliminary Feasibility Study is at a lower confidence level than a Feasibility Study.

Thorough review of the pit designs, production schedules, production rate requirements, and constraints of the project has been concluded that this project might spends 21 years for operating and one-year for pre-production. The major mine equipment consisted of 2 unit of blasthole drilling equipment, 2 unit of excavators, 6 units of hauling truck, and other support equipment to meet the requirement which moving material 2.4 million tons per year from pit to crushing plant. The main crushing plant equipment is comprised of a jaw crusher as primary crusher, 2 units of cone crusher used as secondary and tertiary crusher, vibrating screen, belt conveyor, and dust collector. The finish product of aggregate consisted of 0-4 mm, 4.75-9.5 mm, 9.5-12.5 mm, 12.5-25 mm and 25-63 mm.

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The financial analysis indicated that the project required capital cost of 598.92 million baht to setup, an average operating cost is 59.22 baht/ton or 148 million baht/year over life of mine. A discount rate used in cash flow calculation is 13.4% under the project capital structure of 80% equity and 20% loan. The discounted cash flow model (DCF) of the financial project indicated that $NPV_{13.4\%}$ is 2,335 million baht and MIRR obtained 22.41% with 1.6 years payback period. The sensitivity analysis of the financial model shown that this project is most sensitive to changes in cash flow, which is manifested as changes in aggregate price. For example, a 30% increase in aggregate price leads to raises $NPV_{13.4\%}$ from 2,335 million baht to 3,442 million baht. In contrast, a decrease of 30% in aggregate price results in a 53.62% decrease in $NPV_{13.4\%}$. However, the project still has profit in decrease in aggregate price of 30%.

Therefore, the financial analysis result demonstrates that this project is technically viable and has the potential to generate robust economic returns based on the assumptions and conditions set out in this study. We conclude that this project could advance to the next level of investigation, which is a Feasibility Study.

5.2 Recommendations

Based on the results of this preliminary feasibility study, it is recommended that the project could move forward to the next phase. A detail list recommendation including estimated costs to move the project through to completion of a feasibility study and through the regulation process for mine development. The estimation has been factored on some poor results received early in the evaluation. Discretionary expenditures for this activity would be significantly less than indicated, while exceptional results could require higher expenditures than indicated.

The detailed recommendations have been grouped into categories including:

- Further confirmation drilling to improve confidence.
- Ore reserve estimation should be increased more detail.
- Advance environmental and closure related technical studies based on additional field and laboratory information generated.
- Continue baseline data collection, environmental compliance and reclamation.

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APPENDIX A

Pit Design

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Report of pit design volume by elevation

SOLID MODELLING OBJECT REPORT						
Layer Name: orebody_solid_2.dtm						
Elevation Interval : 5						
Object: 8						
Trisolation: 1						
Validated = true						
Status = solid						
Trisolation Extents						
X Minimum: 568708.051 X Maximum: 569275.575						
Y Minimum: 1535370.224 Y Maximum: 1535828.587						
Z Minimum: -85.000 Z Maximum: 115.554						
Volumes By Elevation						
From	To	Volume (m^3)	Avg. Horizontal Area (m^2)	Surface Area	Cumulative Volume	Cumulative Surface
-85	-80	208,759	41,752	45,633	208,759	45,633
-80	-75	212,463	42,493	4,282	421,222	49,915
-75	-70	231,376	46,275	8,168	652,598	58,083
-70	-65	267,003	53,401	8,706	919,601	66,789
-65	-60	287,700	57,540	4,892	1,207,301	71,681
-60	-55	291,961	58,392	4,923	1,499,262	76,604
-55	-50	313,569	62,714	9,317	1,812,831	85,921
-50	-45	354,031	70,806	9,846	2,166,862	95,767
-45	-40	377,406	75,481	5,494	2,544,268	101,261
-40	-35	382,189	76,438	5,524	2,926,457	106,785
-35	-30	406,207	81,241	10,366	3,332,664	117,151
-30	-25	451,196	90,239	10,945	3,783,860	128,096
-25	-20	477,198	95,440	6,065	4,261,058	134,161
-20	-15	482,476	96,495	6,093	4,743,534	140,254
-15	-10	509,149	101,830	11,459	5,252,683	151,713
-10	-5	558,508	111,702	11,923	5,811,191	163,636
-5	0	586,715	117,343	6,625	6,397,906	170,261
0	5	592,479	118,496	6,653	6,990,385	176,914
5	10	621,569	124,314	12,488	7,611,954	189,402
10	15	675,269	135,054	12,950	8,287,223	202,352
15	20	705,887	141,177	7,184	8,993,110	209,536
20	25	712,136	142,427	7,212	9,705,246	216,748
25	30	743,639	148,728	13,516	10,448,885	230,264
30	35	801,681	160,336	13,978	11,250,566	244,242
35	40	848,129	169,626	10,212	12,098,695	254,454
40	45	882,082	176,416	10,395	12,980,777	264,849
45	50	902,668	180,534	8,030	13,883,445	272,879
50	55	906,292	181,258	11,008	14,789,737	283,887
55	60	883,306	176,661	18,153	15,673,043	302,040
60	65	834,159	166,832	24,241	16,507,202	326,281
65	70	718,886	143,777	46,301	17,226,088	372,582
70	75	613,916	122,783	32,715	17,840,004	405,297
75	80	507,960	101,592	19,607	18,347,964	424,904
80	85	409,355	81,871	27,658	18,757,319	452,562
85	90	293,580	58,716	29,172	19,050,899	481,734
90	95	170,701	34,140	22,384	19,221,600	504,118
95	100	93,085	18,617	12,286	19,314,685	516,404
100	105	52,828	10,566	7,896	19,367,513	524,300
105	110	21,388	4,278	6,704	19,388,901	531,004
110	115	3,526	705	1,772	19,392,427	532,776
115	120	31	6	86	19,392,458	532,862
Total		19,392,458		532,862		

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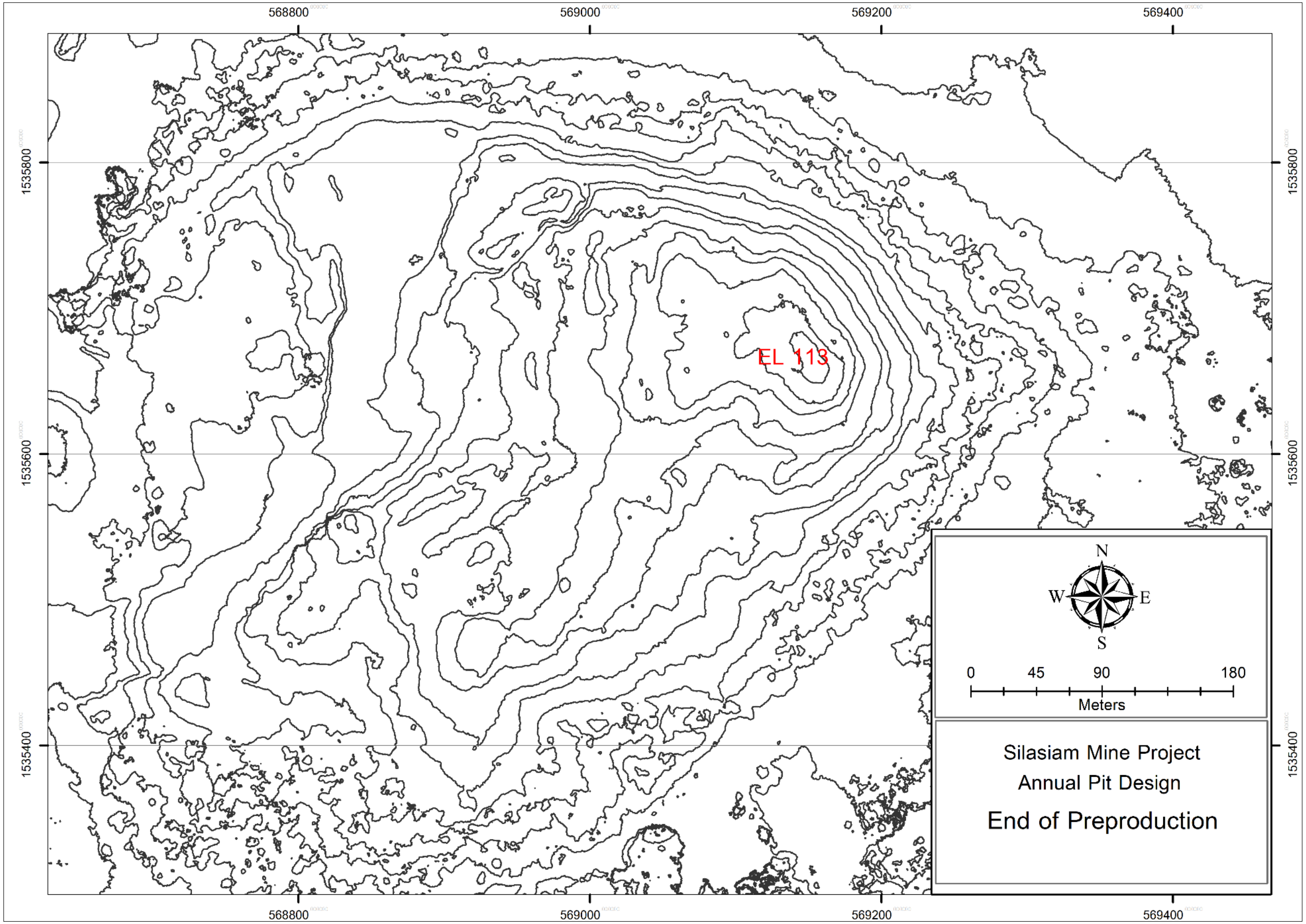
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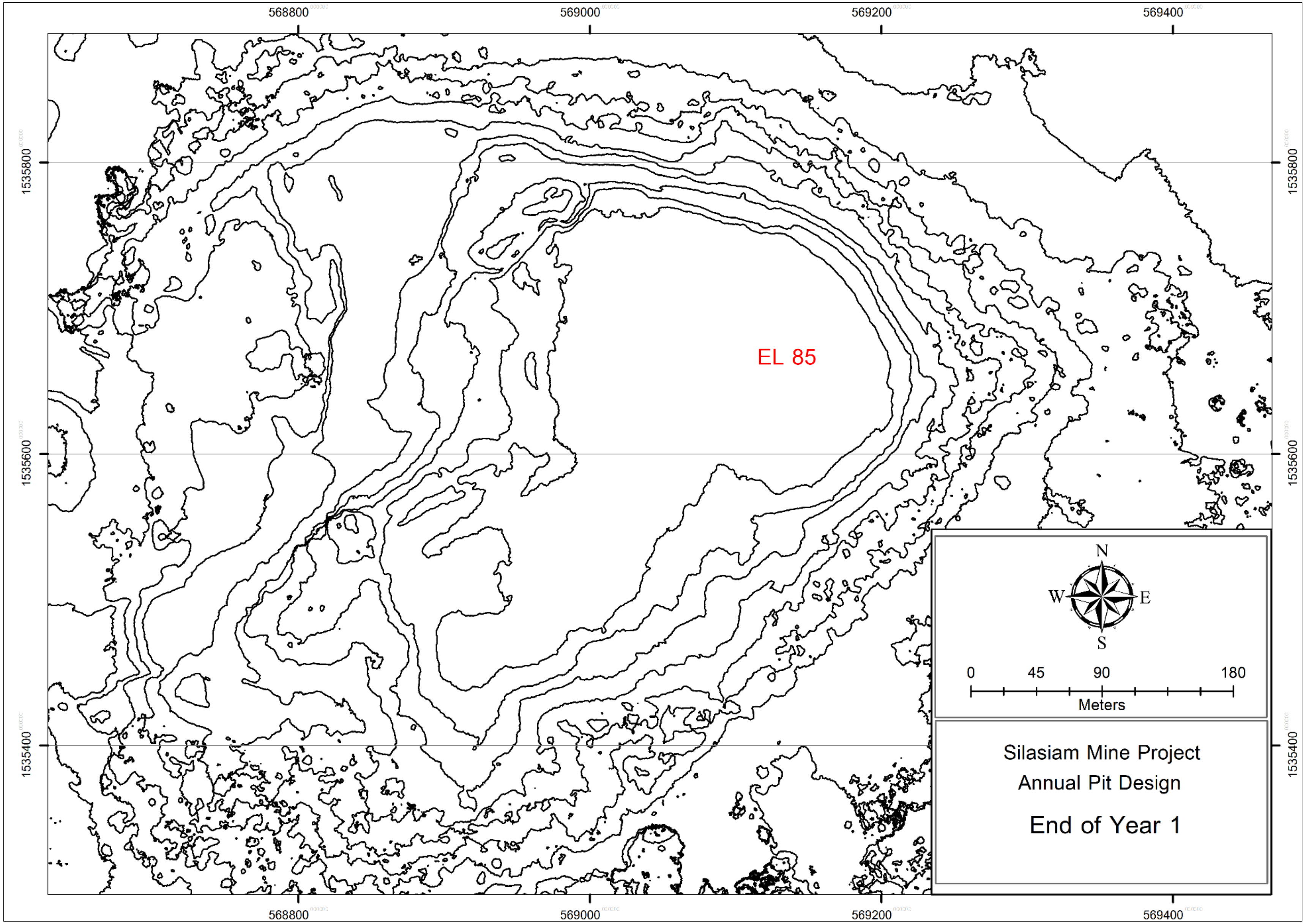
Annual Pit Design
End of Preproduction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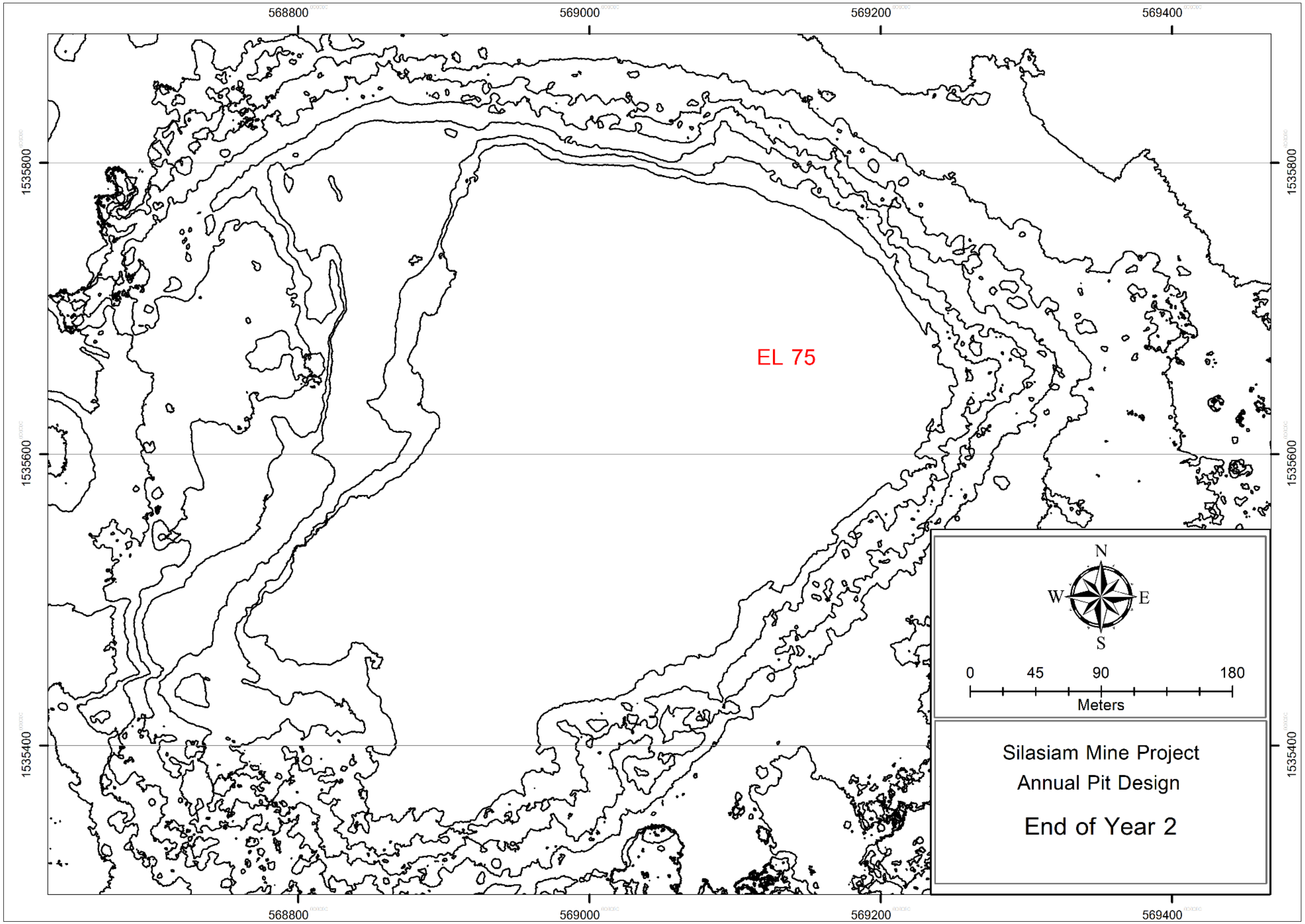
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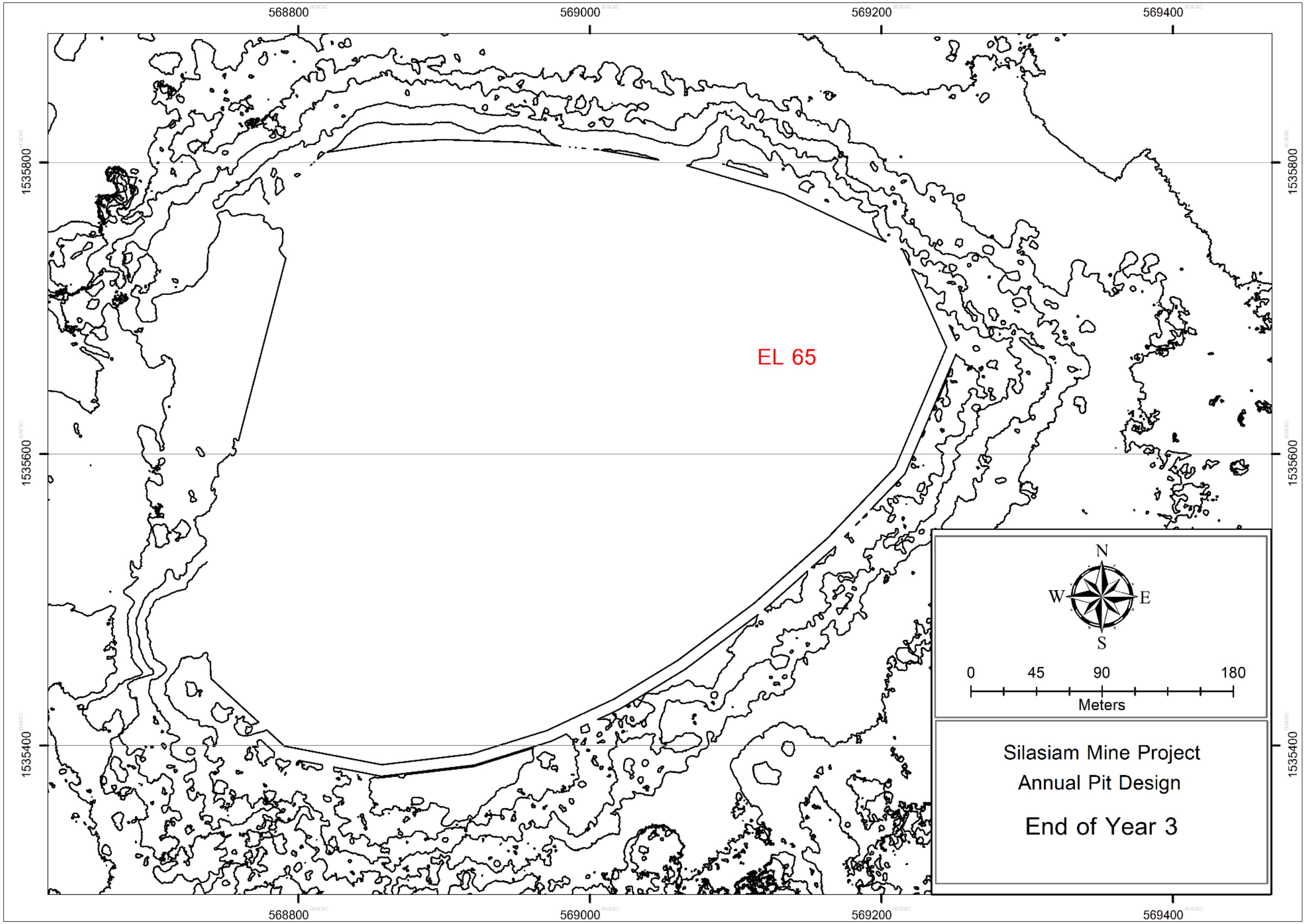
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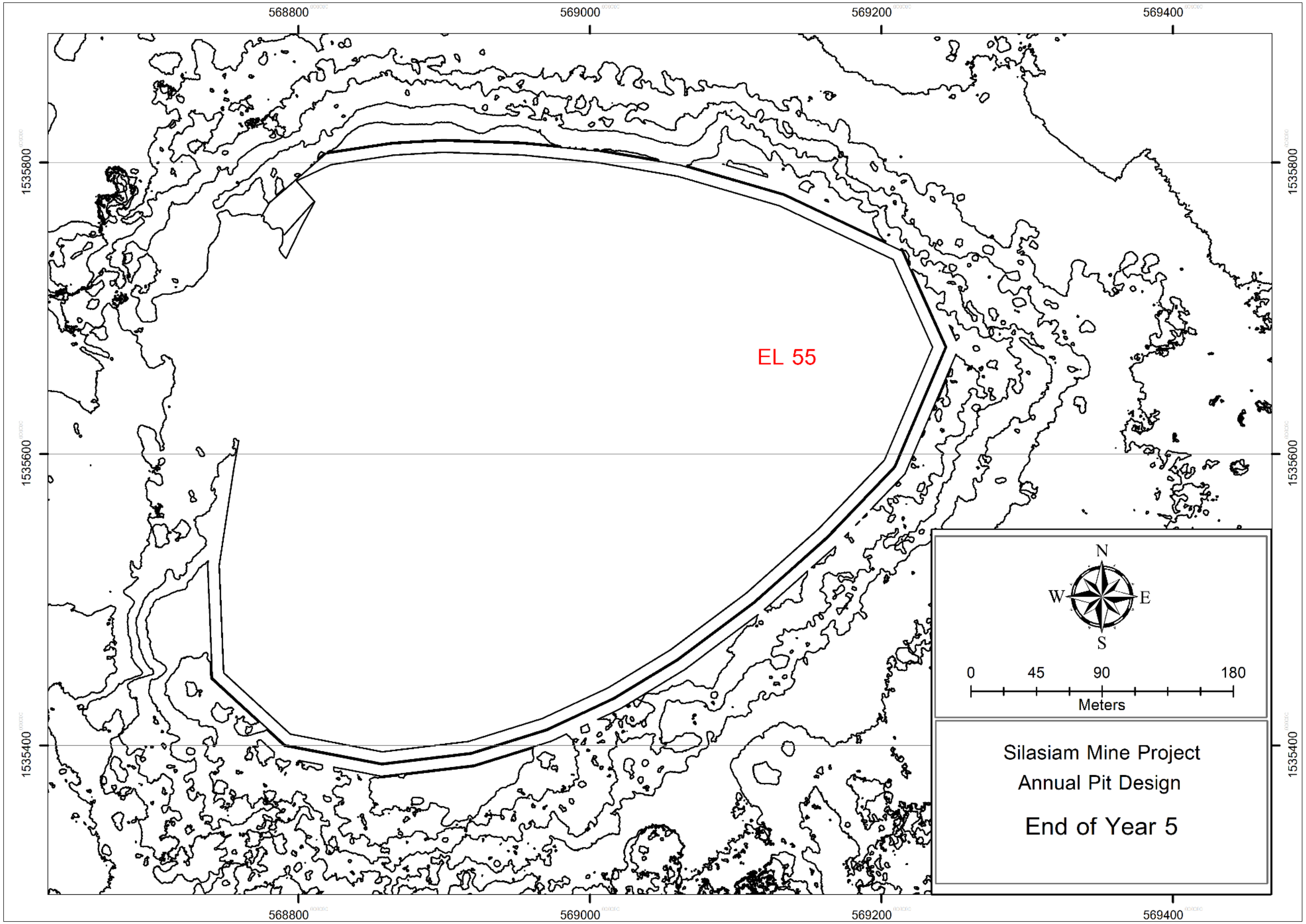
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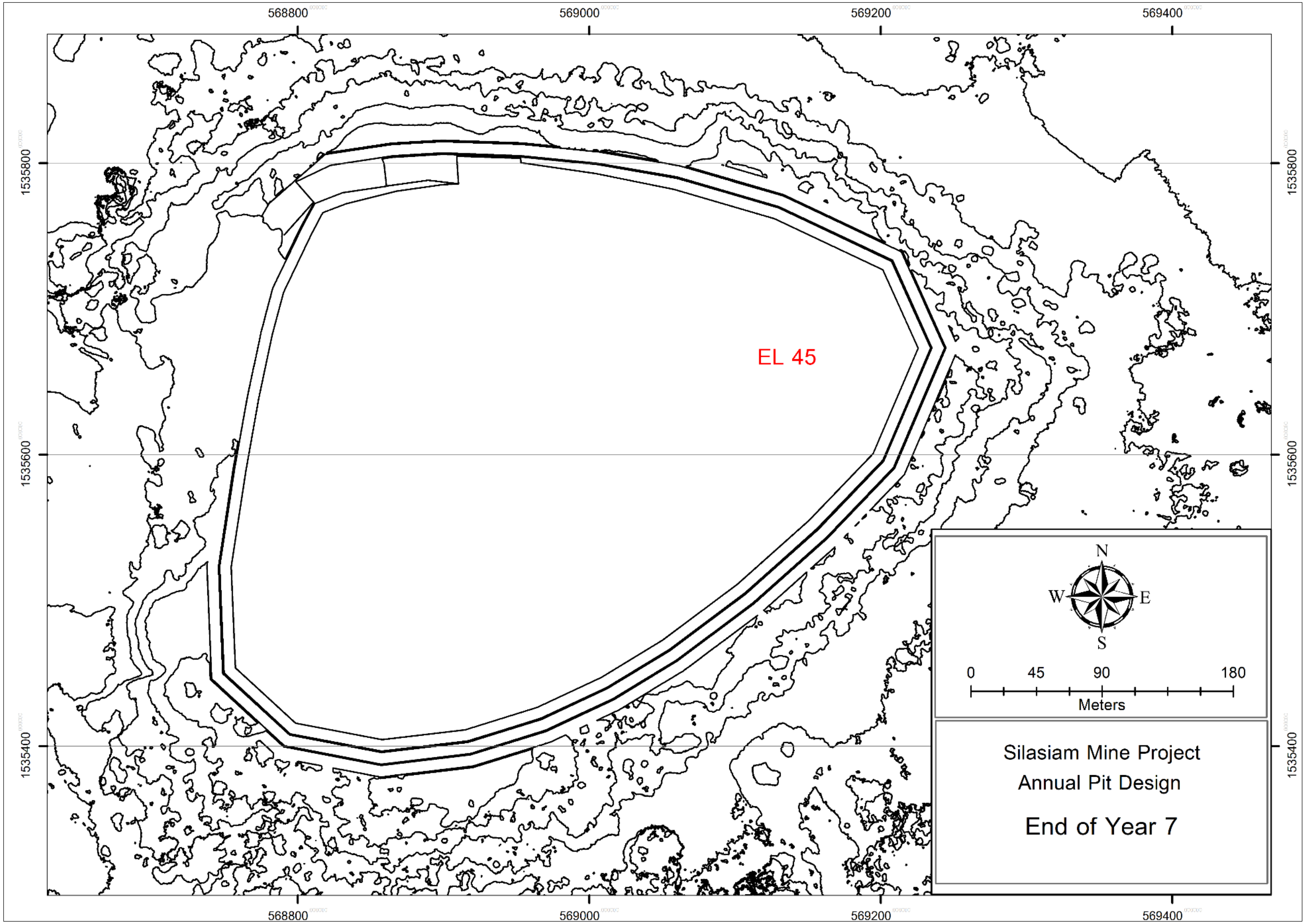

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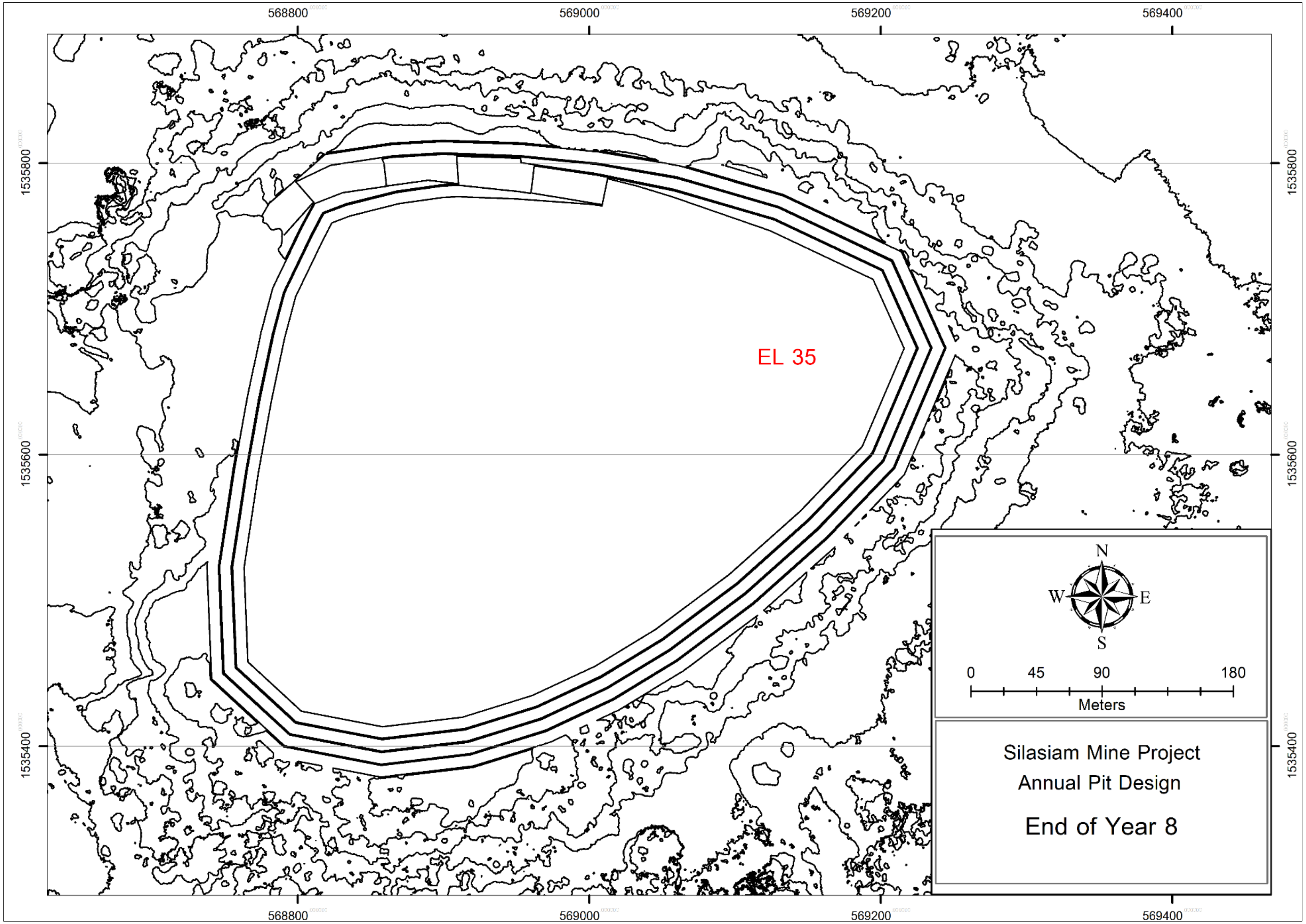
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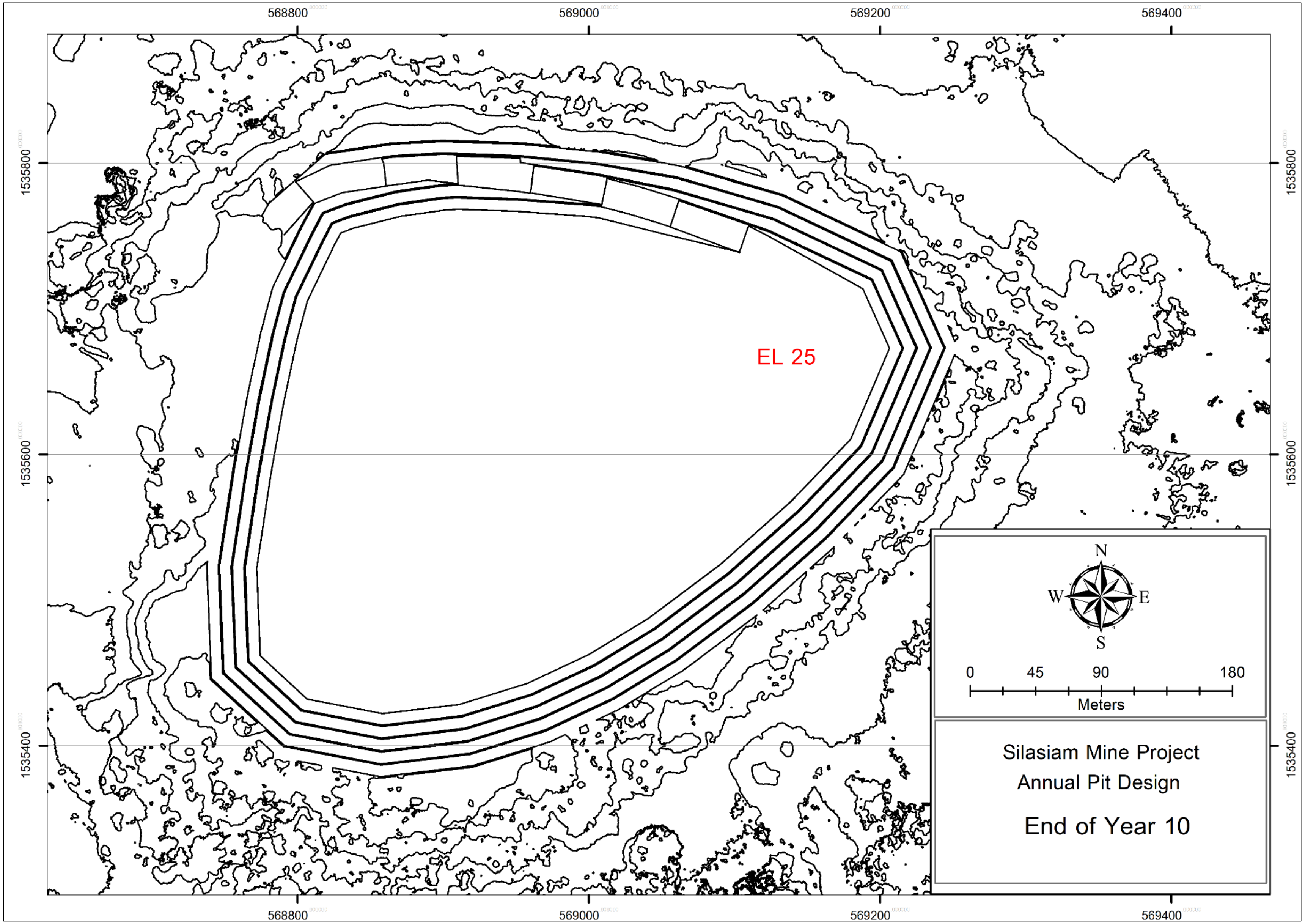
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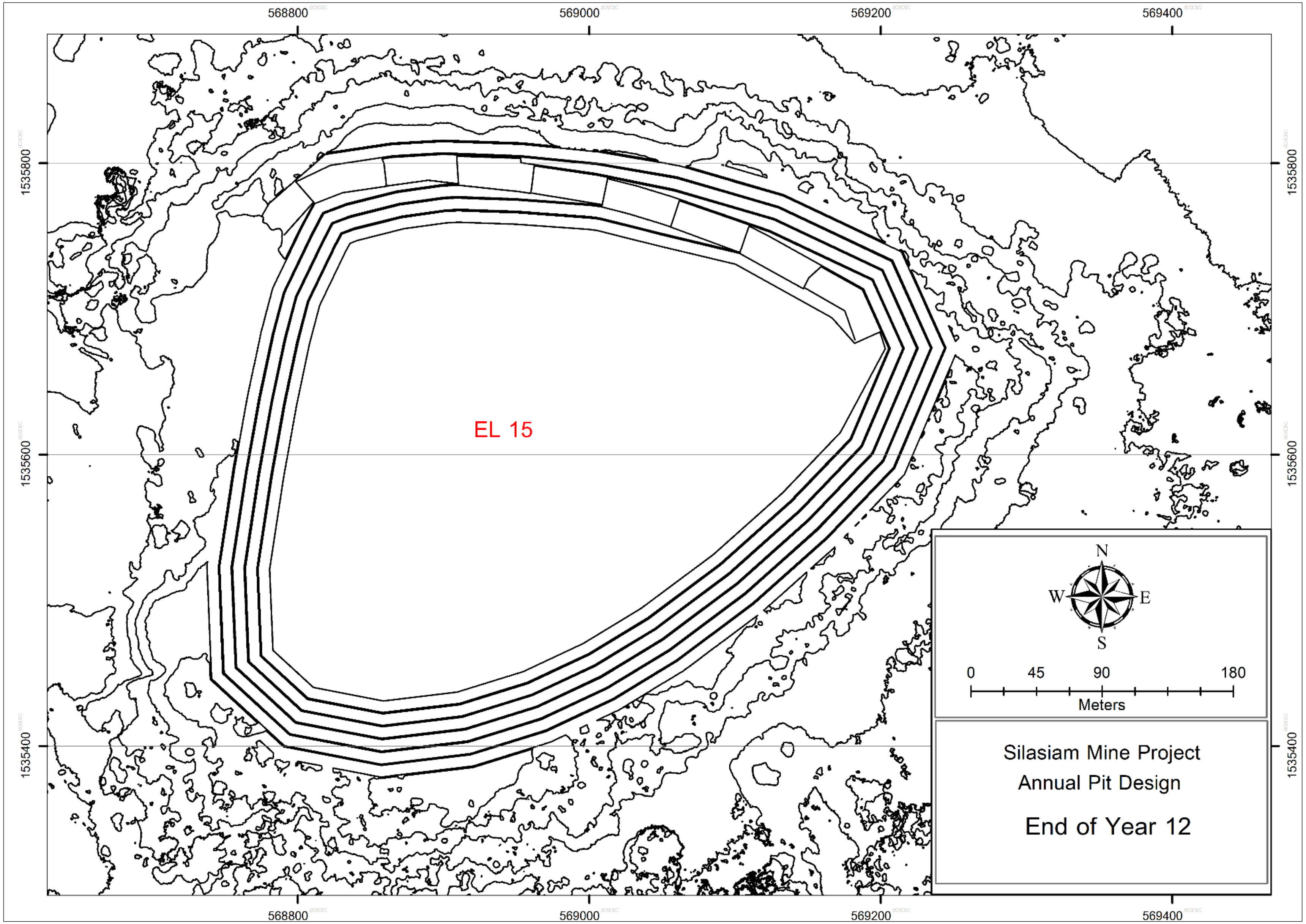
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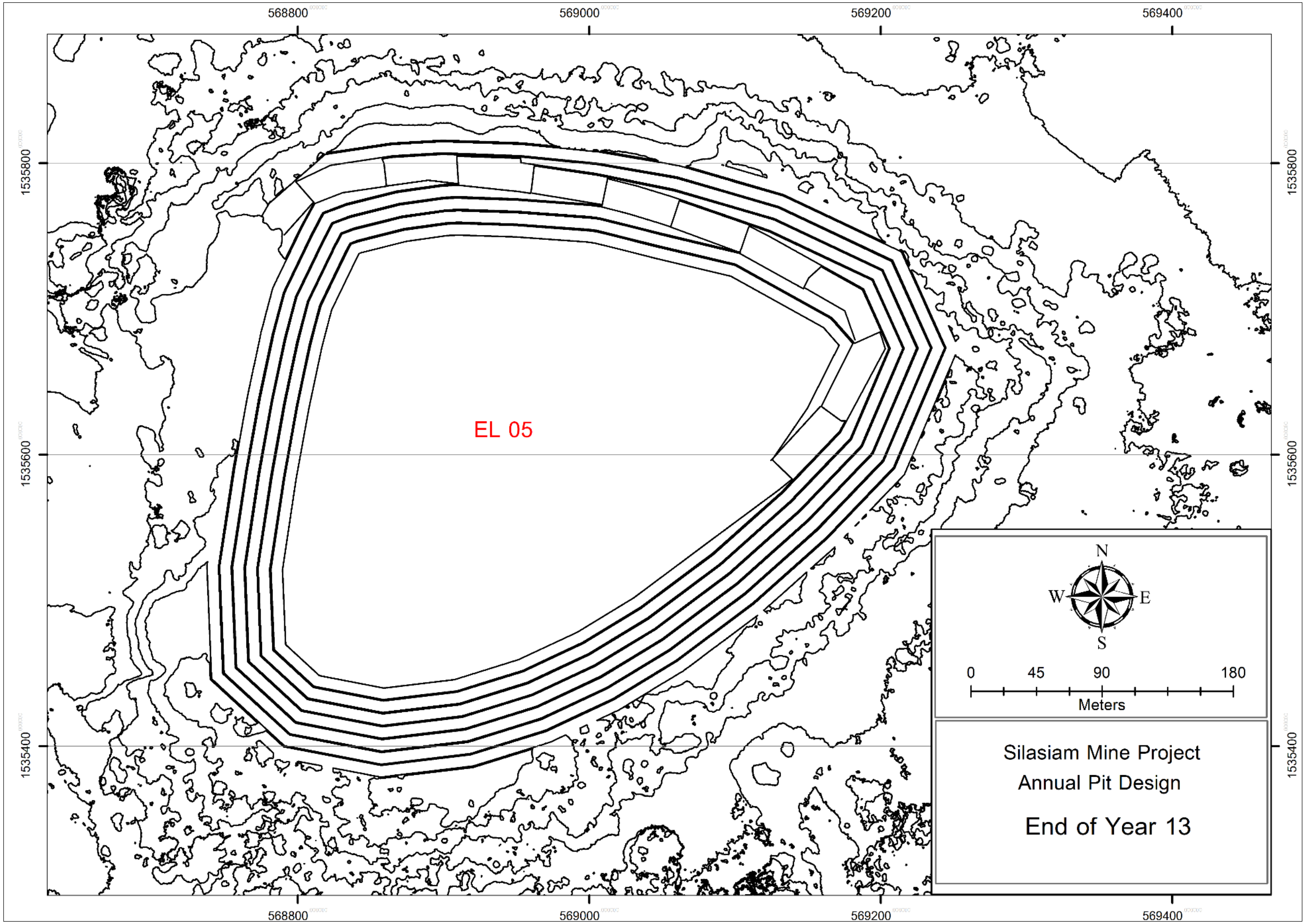
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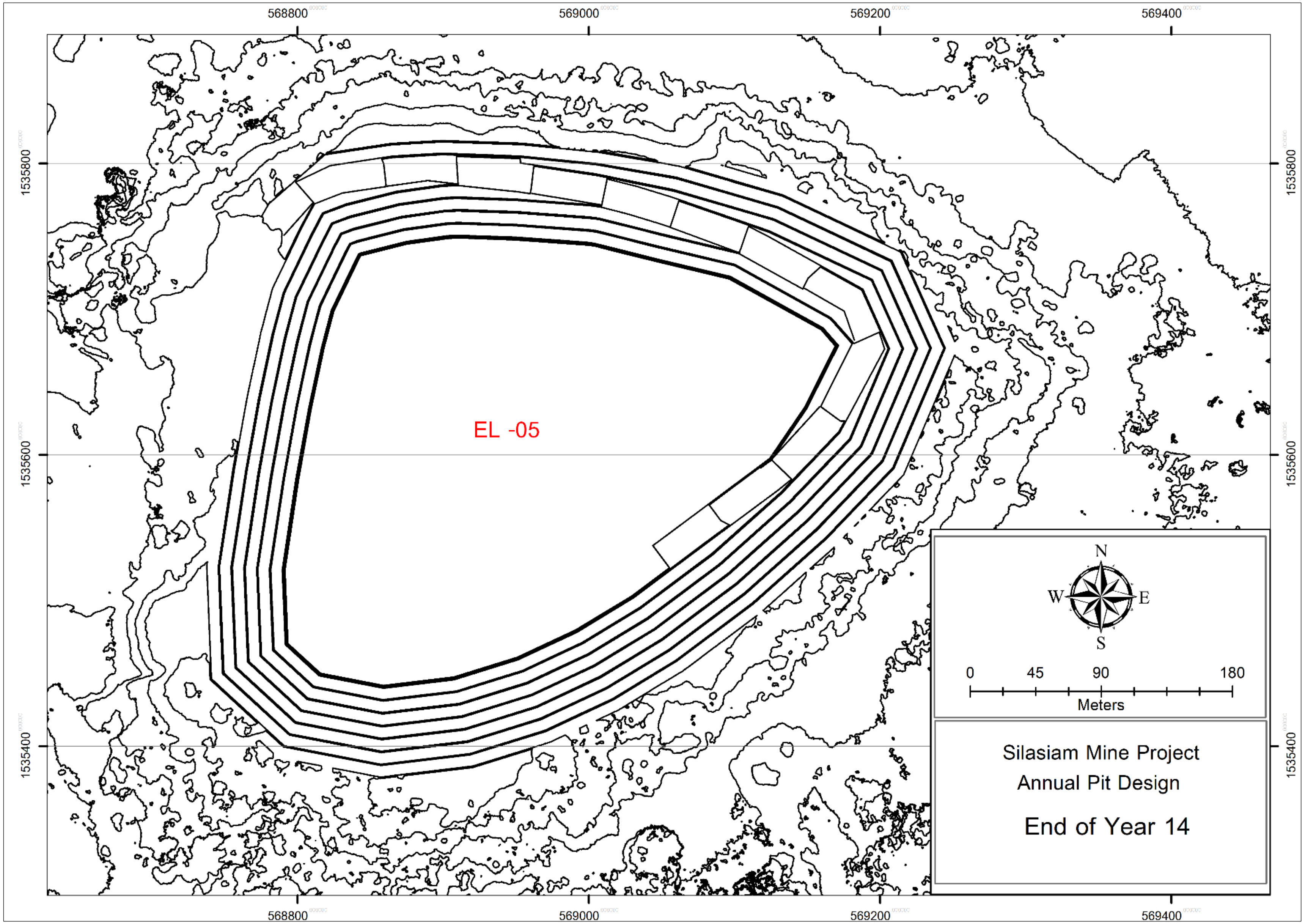
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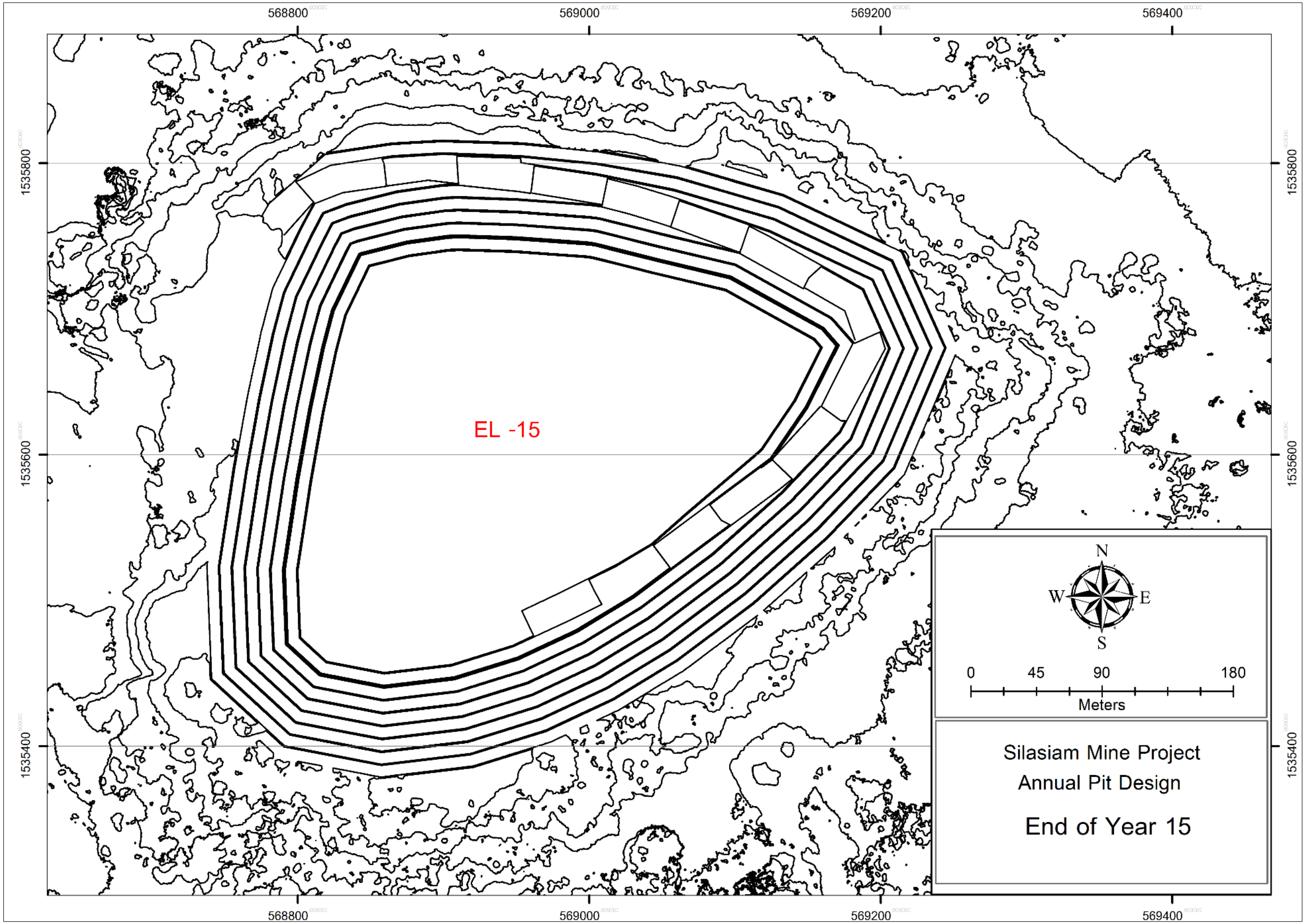
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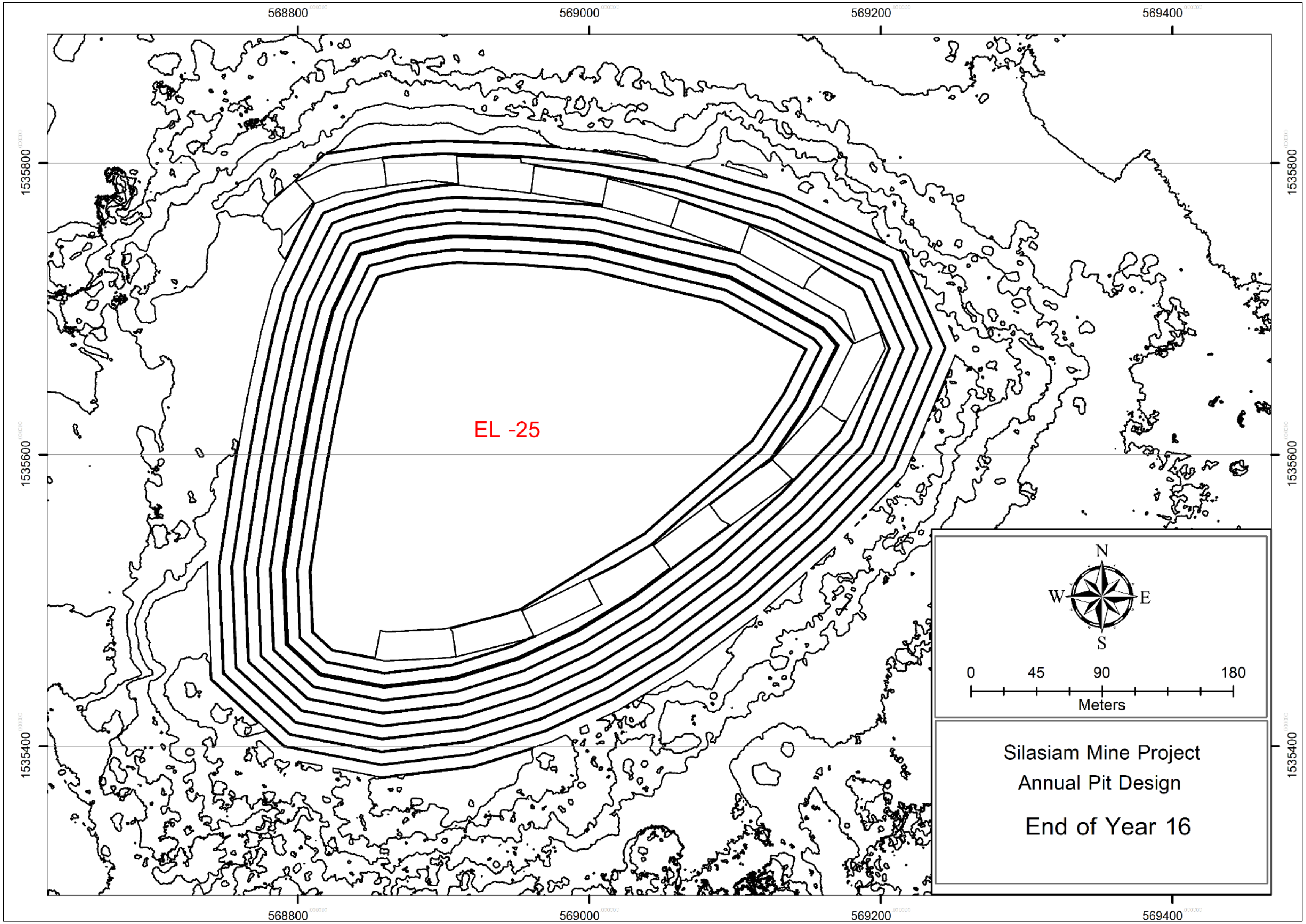
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Annual Pit Design
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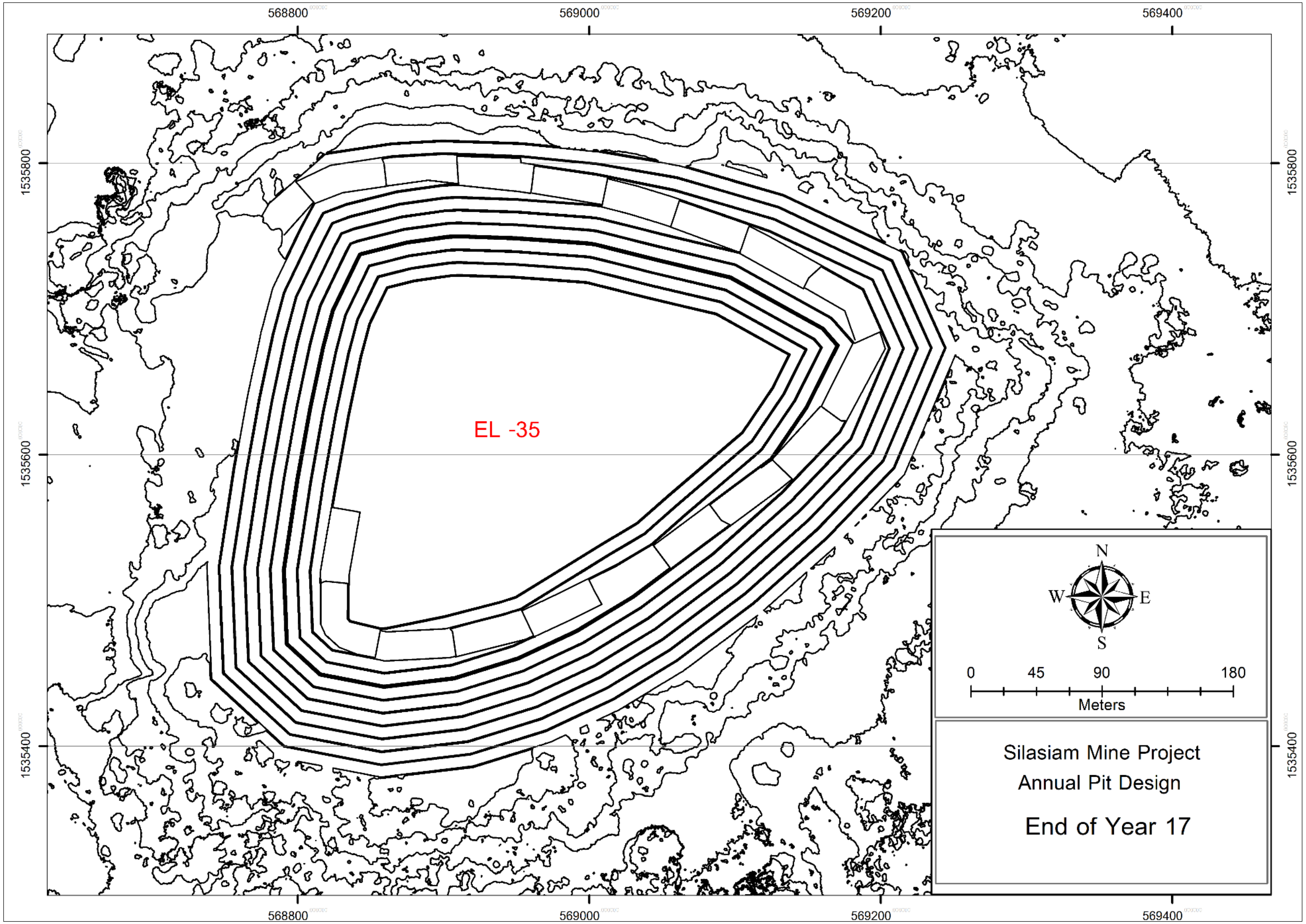
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Annual Pit Design
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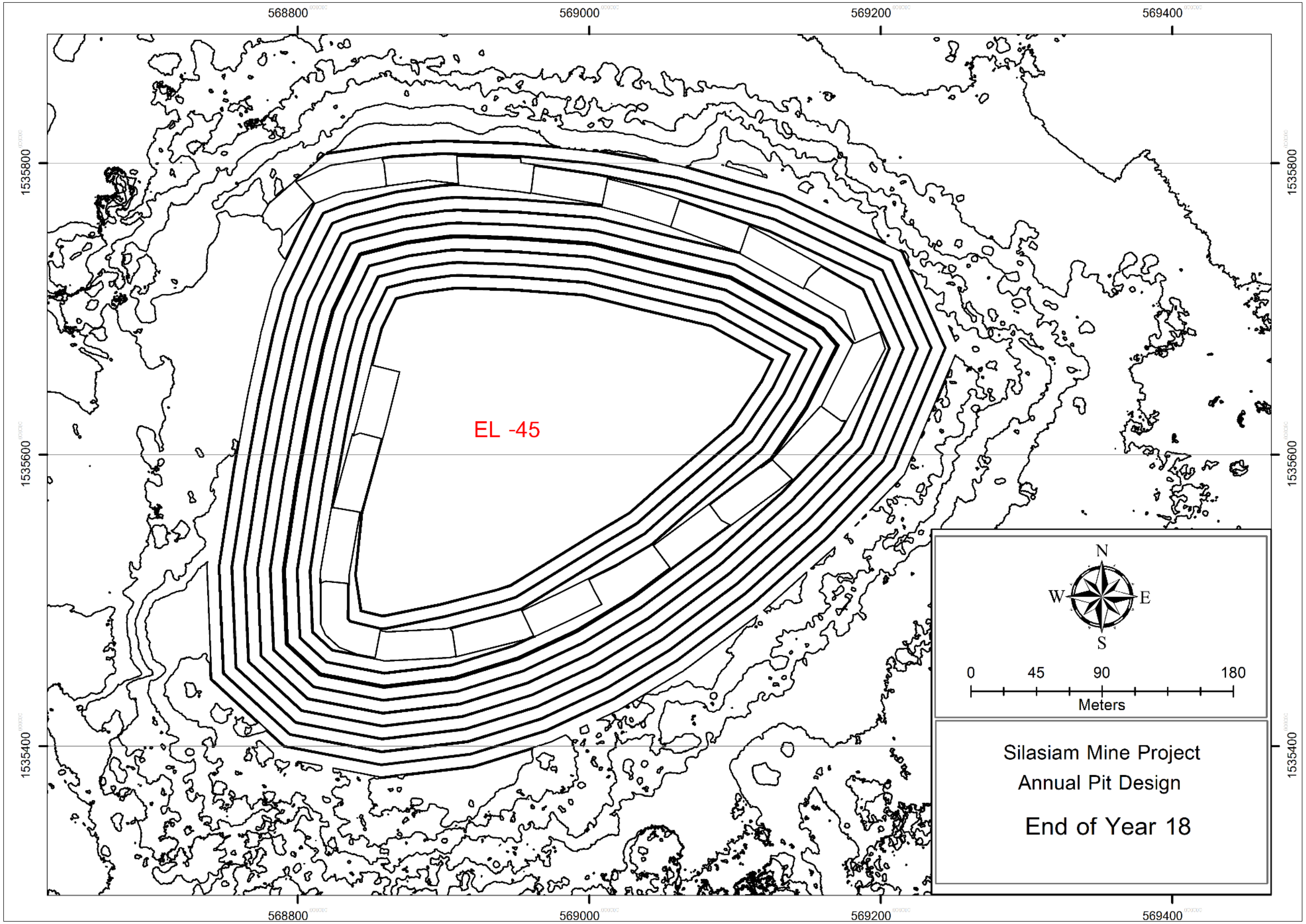
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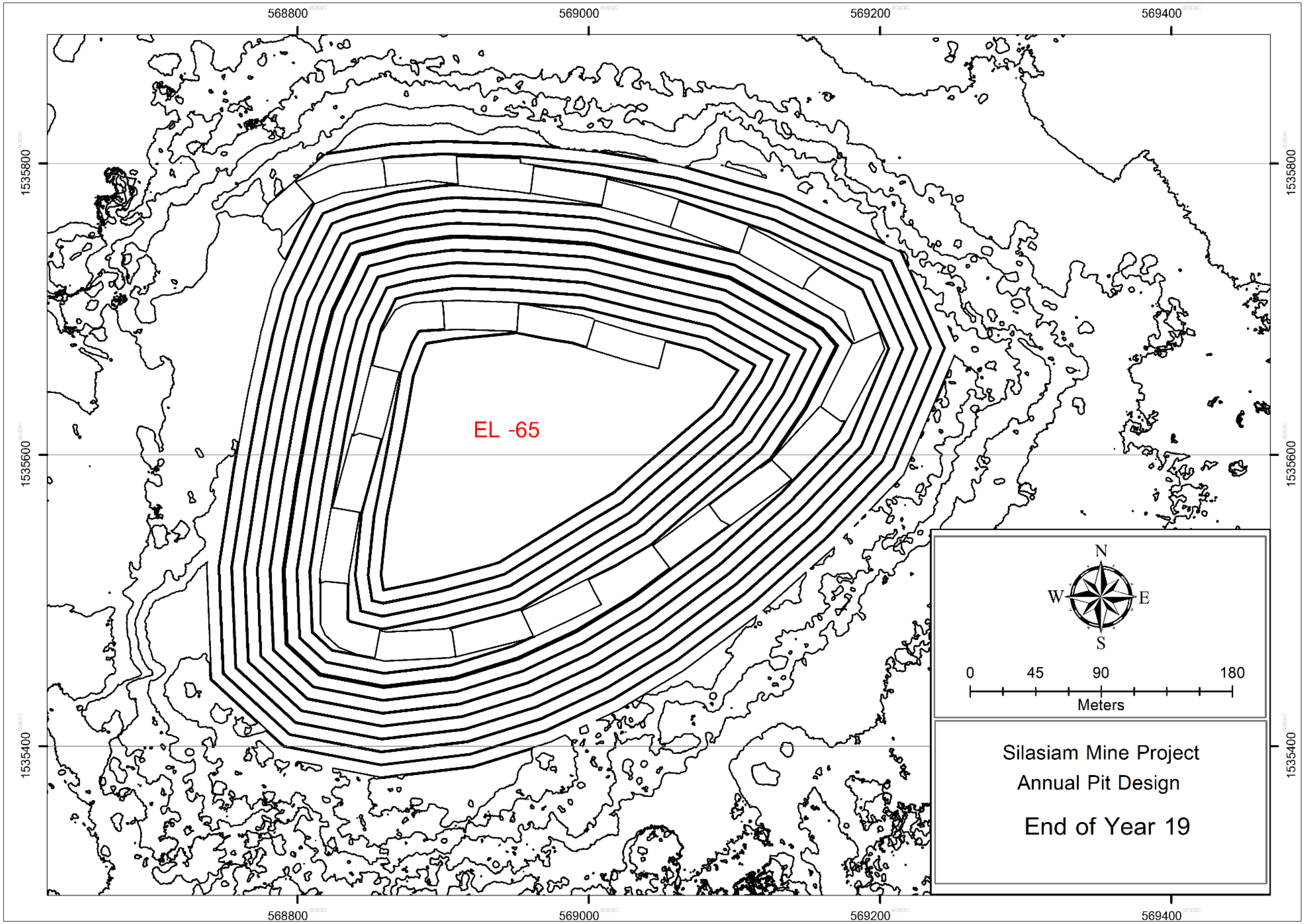
Annual Pit Design
End of Year 18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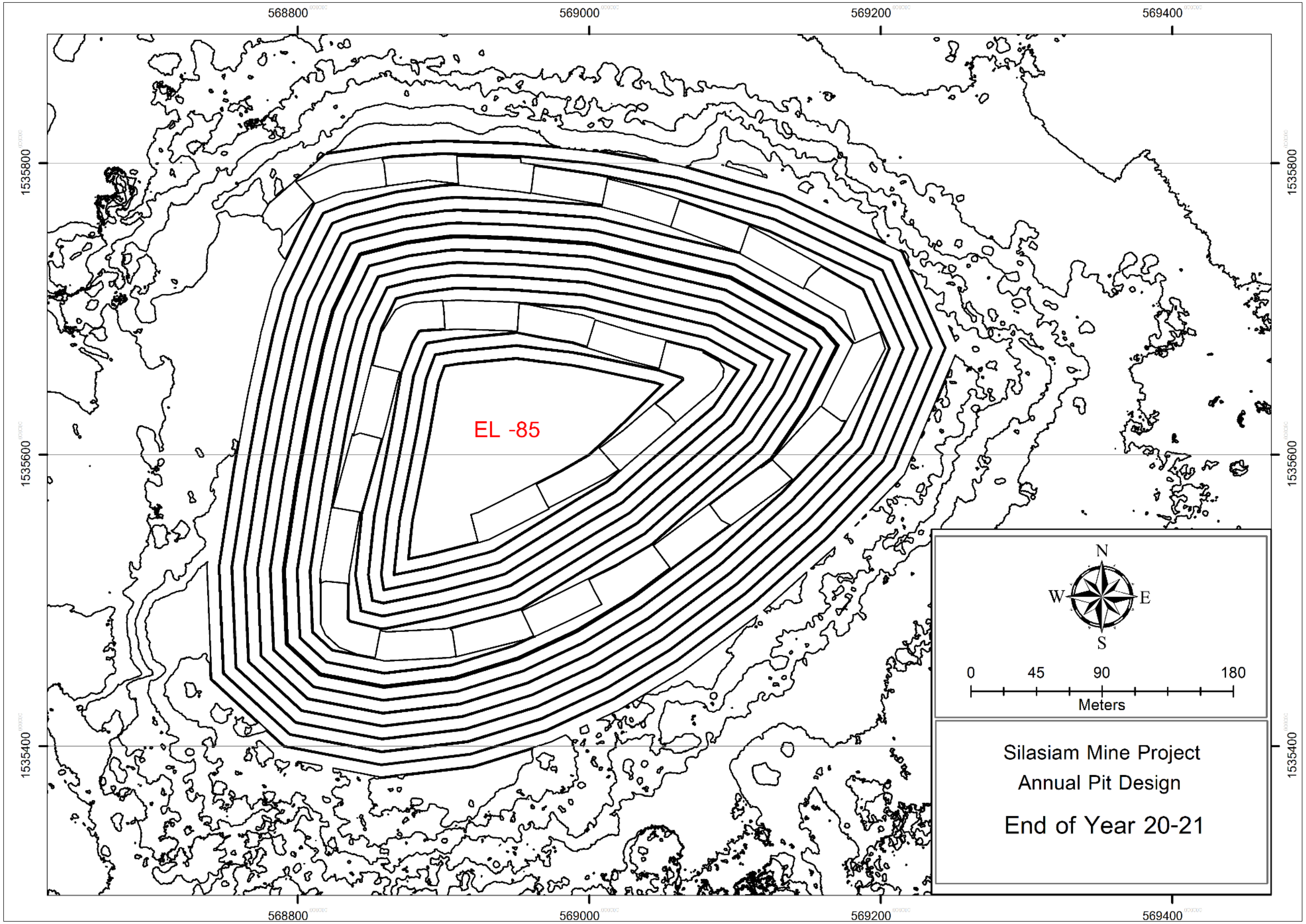
Annual Pit Design
End of Year 19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Silasiam Mine Project
Annual Pit Design
End of Year 20-21

APPENDIX B

Capital Cost

จุฬาลงกรณ์มหาวิทยาลัย
Chulalongkorn University

Capital cost estimation

Capital Cost Area	Detail	Initial CAPEX	Sustaining CAPEX	Closure CAPEX	Total CAPEX
Direct Costs	Mine Cost	฿ 201,581,000	฿ 161,400,000	-	฿ 362,981,000
	Crushing Plant	฿ 63,929,058	฿ 63,929,058	-	฿ 127,858,116
	On-Site Infrastructure	฿ 23,850,000	-	-	฿ 23,850,000
Indirect Cost		฿ 26,333,717	-	-	฿ 26,333,717
Closure and reclamation Costs		-	-	฿ 12,336,321	฿ 12,336,321
License acquisition		฿ 8,750,000	-	-	฿ 8,750,000
Working Capital		฿ 11,370,750	-	-	฿ 11,370,750
Contingency		฿ 25,440,385	-	-	฿ 25,440,385
Total CAPEX with Contingency		**฿361,254,911**	**฿ 225,329,058**	**฿ 12,336,321**	**฿ 598,920,290**

Mine Capital Costs

Mine CAPEX Components	Pre-Production	Sustaining	Total CAPEX
Mine Major Equipment	฿ 157,000,000	฿ 143,000,000	฿ 300,000,000
Mine Support Equipment	฿ 44,581,000	฿ 18,400,000	฿ 62,981,000
Total mine capital costs	**฿ 201,581,000**	**฿ 161,400,000**	**฿ 362,981,000**

Mine Mojor Equipment

Mine Mojor Equipment	Qty (unit)	Cost/unit	Pre-Production	Sustaining	Total CAPEX
Blasthole drills (Caterpillar MD5050)	2	฿ 14,000,000	฿ 28,000,000	฿ 14,000,000	฿ 42,000,000
Hydraulic excavator (Caterpillar 349F)	2	฿ 10,500,000	฿ 21,000,000	฿ 21,000,000	฿ 42,000,000
Caterpillar 772E	6	฿ 18,000,000	฿ 108,000,000	฿ 108,000,000	฿ 216,000,000
Total Mining Mojor Equipment Cost			**฿ 157,000,000**	**฿ 143,000,000**	**฿ 300,000,000**

Mine Support Captial Equipment / Facilities.

Mine Support Equipment / Facilities	Qty (unit)	Cost/unit	Pre-Production	Sustaining	Total CAPEX
Front end loader (Cat 950G)	2	฿ 7,500,000	฿ 15,000,000	฿ 7,500,000	฿ 22,500,000
Bulldozer	1	฿ 9,700,000	฿ 9,700,000	฿ 9,700,000	฿ 19,400,000
Greader (Caterpillar 14 E)	1	฿ 1,200,000	฿ 1,200,000	฿ 1,200,000	฿ 2,400,000
Pickup	4	฿ 1,000,000	฿ 4,000,000	฿ -	฿ 4,000,000
Fuel Truck	1	฿ 651,000	฿ 651,000	฿ -	฿ 651,000
Water truck	1	฿ 420,000	฿ 420,000	฿ -	฿ 420,000
Pit Dewatering machine (Pump@80m.H)	1	฿ 1,000,000	฿ 1,000,000	฿ -	฿ 1,000,000
Engineer/Geology Equipment	1	฿ 50,000	฿ 50,000	฿ -	฿ 50,000
Shop Tools (3% of Major Equipment)	1	฿ 4,710,000	฿ 4,710,000	฿ -	฿ 4,710,000
Initial Spare Parts (5% of Major Equipment)	1	฿ 7,850,000	฿ 7,850,000	฿ -	฿ 7,850,000
Total mine support equipment cost			**฿ 44,581,000**	**฿ 18,400,000**	**฿ 62,981,000**

Crushing Plant Capital Cost

Area Description	Model	Qty	Pre-Production	Sustaining	Total CAPEX
Moter		1	฿ 1,289,300	฿ 1,289,300	฿ 2,578,600
Control system		1	฿ 3,500,000	฿ 3,500,000	฿ 7,000,000
Weighing machine (60-80 ton + installation)		1	฿ 11,110,000	฿ 11,110,000	฿ 22,220,000
Vibrating feeder	F5X1360	1	฿ 1,541,640	฿ 1,541,640	฿ 3,083,280
Jaw crusher	PEW1100	1	฿ 7,272,750	฿ 7,272,750	฿ 14,545,500
Vibrating feeder	ZSW200x120	2	฿ 191,250	฿ 191,250	฿ 382,500
Vibrating feeder	S5X2760-2	1	฿ 1,692,750	฿ 1,692,750	฿ 3,385,500
Cone crusher	GST250(S2)	1	฿ 8,917,890	฿ 8,917,890	฿ 17,835,780
Cone crusher	HST259(S3)	1	฿ 8,917,890	฿ 8,917,890	฿ 17,835,780
Vibrating screen	S5X2760-2	2	฿ 1,692,750	฿ 1,692,750	฿ 3,385,500
Vibrating screen	S5X2160-3	1	฿ 1,627,890	฿ 1,627,890	฿ 3,255,780
Vibrating screen	S5X2160-2	1	฿ 1,281,750	฿ 1,281,750	฿ 2,563,500
Belt conveyor	B1200-30m	1	฿ 797,250	฿ 797,250	฿ 1,594,500
Belt conveyor	B1200-22/43m	1	฿ 1,701,750	฿ 1,701,750	฿ 3,403,500
Belt conveyor	B1400-12/33m	1	฿ 1,537,500	฿ 1,537,500	฿ 3,075,000
Belt conveyor	B1000-10/41m	1	฿ 1,171,140	฿ 1,171,140	฿ 2,342,280
Belt conveyor	B1000-10/28m	1	฿ 937,890	฿ 937,890	฿ 1,875,780
Belt conveyor	B650-20m	4	฿ 306,750	฿ 306,750	฿ 613,500
Belt conveyor	B1000-10/30m	1	฿ 973,890	฿ 973,890	฿ 1,947,780
Belt conveyor	B800-22m	1	฿ 415,500	฿ 415,500	฿ 831,000
Belt conveyor	B800-22m	1	฿ 415,500	฿ 415,500	฿ 831,000
Belt conveyor	B500-20m	1	฿ 279,750	฿ 279,750	฿ 559,500
Belt conveyor	B500-20m	1	฿ 279,750	฿ 279,750	฿ 559,500
Hopper	LC6×6m	1	฿ 17,950	฿ 17,950	฿ 35,900
Dust collector	ZXMC-160-2.5	1	฿ 1,152,053	฿ 1,152,053	฿ 2,304,106
Dust collector	ZXMC-260-2.5	1	฿ 1,872,400	฿ 1,872,400	฿ 3,744,800
Dust collector	ZXMC-380-2.5	1	฿ 2,736,525	฿ 2,736,525	฿ 5,473,050
Magnetic separator	RCYC-12	1	฿ 297,600	฿ 297,600	฿ 595,200
Total Crushing Plant Capital cost			**฿ 63,929,058**	**฿ 63,929,058**	**฿ 127,858,116**

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Chulalongkorn University

Infrastructure

Area Description	Area (sqm)	Bath/sqm	Total CAPEX
Administration Building	400	฿ 8,000	฿ 3,200,000
Warehouse	50	฿ 8,000	฿ 400,000
Truck Shop/ Truck Wash /Truck Warehouse	400	฿ 17,300	฿ 6,920,000
Plant Maintenance Building	400	฿ 17,300	฿ 6,920,000
Permanent camp	500	฿ 7,300	฿ 3,650,000
Fuel Station	30	฿ 8,000	฿ 240,000
Explosives Storage	65	฿ 8,000	฿ 520,000
Funiture			฿ 2,000,000
Total Infrastructure capital cost			**฿ 23,850,000**

Mine closure and reclamation

Item	Cost/unit	Qty	LOM
Tree planting	50	5,460	฿ 272,980
Fertilizer (kg)	15	1,638	฿ 663,341
Equipement	10,000	1	฿ 2,400,000
Other	20,000	1	฿ 4,000,000
Long-term mine closure mornitering			฿ 5,000,000
Total closure cost			**฿ 12,336,321**

Contingency Capital

Contingency Capital Costs	Percentage	Cost (Baht)
Mine Capital	5.0%	฿ 10,079,050
Crusing plant	17.5%	฿ 11,187,585
Infrastructure	17.5%	฿ 4,173,750
Total Contingency Cost		**฿ 25,440,385**

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SBM QUOTATION

上海世邦机器有限公司
SHANGHAI SHIBANG MACHINERY CO.,LTD.
品质与文明之光闪耀世界
THE LIGHT OF QUALITY AND
CIVILIZATION SHINES THE WORLD!

Quotation of 600t/h Crushing Plant
Sila Somboonsup project

From: Karl Wang

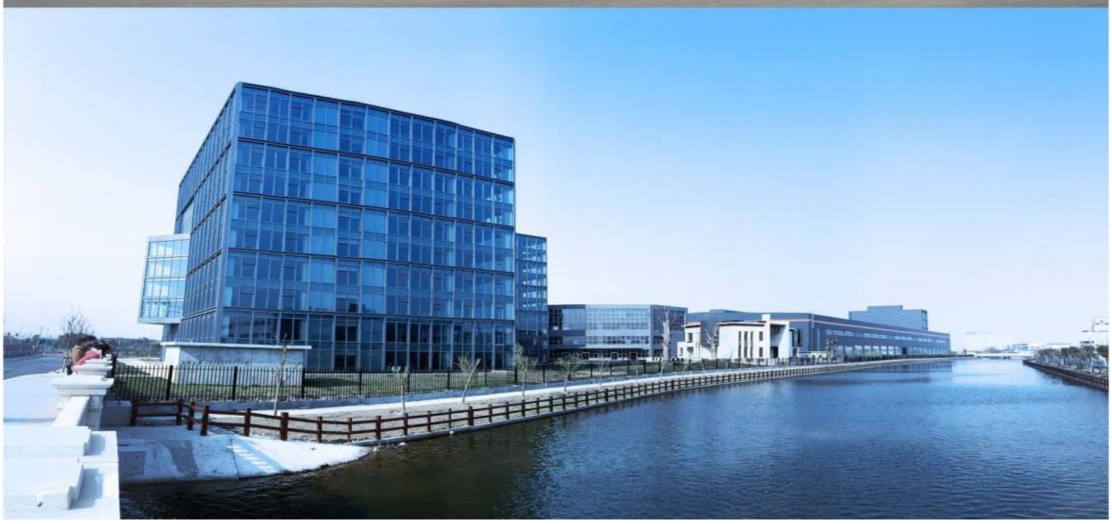
Date: August 10th, 2017

Brief introduction of SBM

Shanghai Shibang Machinery Co., Ltd. is a professional manufacturer of crushing and powder making equipment. It is a major production and export base of sand-stone and powder making machinery in China.

- **Quality products**: all of SBM products have **CE & ISO certificates**;
- **Global reputation**: SBM has exported our machinery to **more than 130 countries**, and have set up**16 oversea offices** in countries which are across **four continents**: Mexico, Brazil and Chile in America; Nigeria, Ghana, and Algeria in Africa; Russia in Europe; India, Indonesia, Vietnam and Malaysia in Asia;
- **Reliable service**: SBM has a customer service center consisting of about 300 people, among which there are about**240 after-sale service engineers** working world-wide to provide service like installation, commission, and maintenance to our customers.

Hereby we thank all the friends who is concerned about and supporting SBM. Thanks for the all the user from every industry who are using SBM crushers. Thanks for all your opportunities to use the SBM crusher, and the space to show the advanced performance.



Contents

♦ Part 1: Basic Information

Supplier: SHANGHAI SHIBANG MACHINERY SALES CO., LTD(SBM)

Attn: ***Karl Wang***

Mob: +86-15102175894

Email: karl@sbmchina.org

Web: www.sbmchina.com /

Add: No.416, Jianye Rd, Pudong New District, Shanghai, China

Sale representative: TGC CON-TEC CO., LTD. By Mr. Suthep Kimkool

Mob.: +090 971 0491

E-mail: tgccontec@gmail.com

Buyer:

Attn: Prof. Somsak Saisinchai

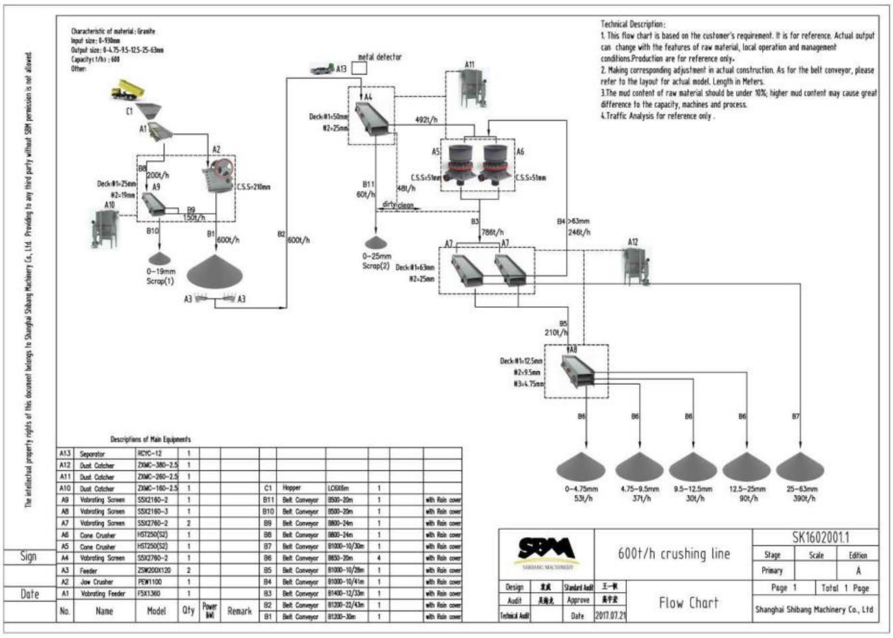
Mob:

Email:

♦ Part 2: Client Requirements

1. **Material:** Granite
2. **Feed Size (mm):** 0-930
3. **Product Size (mm):** 0-4.75-9.5-12.5-25-63
4. **Capacity (t/h) :** 600

♦ **Part 3:** Flow chart



The quotation refers to:

- attached flow chart-mass balance SK1602001.1-20170810

- attached layout drawing SK1602001.2-20170810

- attached crusher catalog

♦ Part 4: Price List

Part A: Basic supply

Alternative 1 :Crushing plant with belt conveyors with covers for rain/dust protection

No		Name	Model	Power (kw)	Qty	Unit Price(USD)	Total Price(USD)
1	A1	Vibrating feeder	F5X1360	30	1	51,388	51,388
2	A2	Jaw crusher	PEW1100	185	1	242,425	242,425
3	A3	Vibrating feeder	ZSW200x120	2.2x2	2	6,375	12,750
4	A4	Vibrating screen	S5X2760-2	30	1	56,425	56,425
5	A5	Cone crusher	HST250(S2)	220	1	297,263	297,263
6	A6	Cone crusher	HST250(S3)	220	1	297,263	297,263
7	A7	Vibrating screen	S5X2760-2	30	2	56,425	112,850
8	A8	Vibrating screen	S5X2160-3	30	1	54,263	54,263
9	A9	Vibrating screen	S5X2160-2	22	1	42,725	42,725
14	B1	Belt conveyor	B1200-30m		1	26,575	26,575
15	B2	Belt conveyor	B1200-22/43m		1	56,725	56,725
16	B3	Belt conveyor	B1400-12/33m		1	51,250	51,250
17	B4	Belt conveyor	B1000-10/41m		1	39,038	39,038
18	B5	Belt conveyor	B1000-10/28m		1	31,263	31,263
19	B6	Belt conveyor	B650-20m		4	10,225	40,900
20	B7	Belt conveyor	B1000-10/30m		1	32,463	32,463
21	B8	Belt conveyor	B800-22m		1	13,850	13,850

22	B9	Belt conveyor	B800-22m		1	13,850	13,850
23	B10	Belt conveyor	B500-20m		1	9,325	9,325
24	B11	Belt conveyor	B500-20m		1	9,325	9,325
25	C1	Hopper	LC6×6m		1	17,950	17,950
Total FOB Shanghai Price							**1,509,863**

Alternative 2 :Crushing plant with belt conveyors without covers for rain/dust protection

No		Name	Model	Power (kw)	Qty	Unit Price(USD)	Total Price(USD)
1	A1	Vibrating feeder	F5X1360	30	1	51,388	51,388
2	A2	Jaw crusher	PEW1100	185	1	242,425	242,425
3	A3	Vibrating feeder	ZSW200x120	2.2x2	2	6,375	12,750
4	A4	Vibrating screen	S5X2760-2	30	1	56,425	56,425
5	A5	Cone crusher	HST250(S2)	220	1	297,263	297,263
6	A6	Cone crusher	HST250(S3)	220	1	297,263	297,263
7	A7	Vibrating screen	S5X2760-2	30	2	56,425	112,850
8	A8	Vibrating screen	S5X2160-3	30	1	54,263	54,263
9	A9	Vibrating screen	S5X2160-2	22	1	42,725	42,725
14	B1	Belt conveyor	B1200-30m		1	22,150	22,150
15	B2	Belt conveyor	B1200-22/43m		1	47,125	47,125
16	B3	Belt conveyor	B1400-12/33m		1	42,950	42,950
17	B4	Belt conveyor	B1000-10/41m		1	33,013	33,013
18	B5	Belt conveyor	B1000-10/28m		1	26,775	26,775

19	B6	Belt conveyor	B650-20m		4	8,688	34,750
20	B7	Belt conveyor	B1000-10/30m		1	27,738	27,738
21	B8	Belt conveyor	B800-22m		1	11,775	11,775
22	B9	Belt conveyor	B800-22m		1	11,775	11,775
23	B10	Belt conveyor	B500-20m		1	7,800	7,800
24	B11	Belt conveyor	B500-20m		1	7,800	7,800
25	C1	Hopper	LC6×6m		1	17,950	17,950
Total FOB Shanghai Price							**1,458,950**

Part B: Optional machines

No		Name	Model	Power (kw)	Qty	Unit Price(USD)	Total Price(USD)
10	A10	Dust collector	ZXMC-160-2.5	22	1	37,163	37,163
11	A11	Dust collector	ZXMC-260-2.5	45	1	60,400	60,400
12	A12	Dust collector	ZXMC-380-2.5	75	1	88,275	88,275
13	A13	Magnetic separator	RCYC-12	4	1	9,600	9,600
Total FOB Shanghai Price							**195,438**

Equipment ,accessories and material can be supplied as the customer's requirement.

26. Electrical control for Crushing plant

27. Electric cable

28. Cable tray, cable ladders etc.

Part C Supervision

: **USD 3,200**

Two technicians from SBM are working for 20 days in the site to instruct and supervise installation, commissioning and training. Extra days after 20 days is 100 USD/man-day. All accommodation (rooms and 3 meals per day) and domestic travels are provided by customer.

Remark:

1. All electric installed power will be informed for the update offer .
2. The exchange rate for USD versus RMB is 6.67(Aug. 10th, 2017)

♦ Part 5: Technical parameter

1- Vibrating feeder, A1

- Model: F5X1360
- Max. feed size(mm): 900
- Max. capacity(t/h): 600
- Motor power(Kw): 30
- Rev of eccentric shaft (rpm): 1000
- Size of funnel (mm): 1300×6000
- Install inclination (°): 5
- Overall dimension (L*W*H) (mm): 6195×1960×1680

- **Jaw crusher, A2**

- Model: PEW1100
- Feed Opening (mm): 1100*1200
- Max Feeding Size (mm): 930 Adjustable Range of Discharge Opening(mm): 150-275
- Capacity (t/h): 300-650
- Rotation speed of shaft (r/min): 210
- Power (kw): 185
- Overall Dimension (mm): 4140×2660×3560

2- Vibrating feeder, A3

- Model: ZSW200*120
- Max feed size (mm): 300
- Capacity (t/h): 80-500
- Rev of eccentric shaft (rpm): 970
- Motor power (kw): 2.2×2
- Size of funnel (mm): 2000*1200
- Overall dimension (mm): 2000×1200×855

3- Vibrating screens, including

4.1 Vibrating screen, A4

- Model: S5X2760-2
- Specification of screen (mm): 2700*6000
- Layers: 2
- Sieve pore size (mm): 2-70
- Feed size (mm): ≤200
- Capacity (t/h): 120-900
- Power (kw):30
- Rotating speed (rpm): 800-900
- Double amplitude (mm): 7-12
- Overall dimension (mm): 6223×4550×3469

4.2 Vibrating screen, A7 and A9

- Model: S5X2160-2
- Specification of screen (mm): 2100*6000
- Layers: 2
- Sieve pore size (mm): 2-70
- Feed size (mm): ≤200
- Capacity (t/h): 85-700
- Power (kw):22
- Rotating speed (rpm): 800-900
- Double amplitude (mm): 7-12
- Overall dimension (mm): 6223×3907×3437

4.3 Vibrating screen, A8

- Model: S5X2160-3
- Specification of screen (mm): 2100*6000
- Layers: 3
- Sieve pore size (mm): 2-70
- Feed size (mm): ≤200
- Capacity (t/h): 85-700
- Power (kw):30
- Rotating speed (rpm): 800-900
- Double amplitude (mm): 7-12
- Overall dimension (mm): 6223×3948×4016

4- Cone crushers, A5

- Model: HST250(S2)
- Maximum feeding size(mm): 400
- Minimum discharging size(mm):29
- Capacity (t/h): 215~515
- Power (kw): 220
- Overall Dimension (mm): 2100×2320×4096

5- Dust collectors

6.1 Dust collectors, A10

- Model: ZXMC-160-2.5
- Filtering wind speed (m/min): 2.3-2.5
- Filter area (m2):160

- Airflow(m3/h): 22080~24000
- Matching blower: G4-73No6.5C
- Rotating speed(r/min):2000
- Power(Kw): 22
- Air flow(m3/h): 23523-25223
- Full pressure(Pa): 2448-2127

6.2 **Dust collectors, A11**

- Model: ZXMC-260-2.5
- Filtering wind speed (m/min): 2.3-2.5
- Filter area (m2):260
- Airflow(m3/h): 35880~40560
- Matching blower: G4-73No10C
- Rotating speed(r/min):1370
- Power(Kw): 45
- Air flow(m3/h): 37721-45427
- Full pressure(Pa): 2902-2694
-

6.3 Dust collectors, A12

- Model: ZXMC-380-2.5
- Filtering wind speed (m/min): 2.3-2.5
- Filter area (m2):380
- Airflow(m3/h): 52440~57000
- Matching blower: G4-73No11C
- Rotating speed(r/min):1350
- Power(Kw): 75
- Air flow(m3/h): 54527-59581
- Full pressure(Pa): 3319-3164

6- Magnetic separator

- Model: RCYC-12
- Applicable belt width (mm):1200
- Rated suspension height (mm):350
- Intensity (at RSH) (Gs): ≥70
- Excitation power(Kw): ≤4

7- Belt conveyors

- Model: B1400/B1200/B1000/B800/B650/B500
- Width (mm): 1400/1200/1000/800/650/500
- Angle (°): 0-17
- Belt speed (m/s): 1.0-2.0
- Capacity (t/h): 100-800

Cover sheet forrain/dust protection.

APPENDIX C

Operating Cost

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Average Cash Operating Cost

Operating cost item	Average cash operating cost (Baht/ton)
Mining OPEX	฿ 31.63
Crushing OPEX	฿ 24.32
General & Adminstrative OPEX	฿ 3.27
Average Cash Operating Cost	**฿ 59.22**

price assumptions for power

Consumable	Unit	Price estimates	Comment
Power	Baht/kWhr	4.00	Quote for off-road to site
Fuel	Baht/liter	25.00	Price rate quote

Minig OPEX cost

Mining Function	percentage	Cost (Baht/ton)
Drilling	10.02%	3.17
Blasting	14.86%	4.70
Loading	11.45%	3.62
Hualing	44.19%	13.98
G&A	11.30%	3.58
Mine support	8.17%	2.59
Total mining OPEX cost		**฿ 31.63**

Mining labor cost

Employee duty	Qty	Personal Salary	Total salary	Unit
Mine Manager	1	50,000	50,000	baht/month
Engineer	1	35,000	35,000	baht/month
Maintenance	4	18,000	72,000	baht/month
Security	2	9,000	18,000	baht/month
Excuvator	2	23,000	46,000	baht/month
Driller	2	23,000	46,000	baht/month
Blaster	2	23,000	46,000	baht/month
Dump truck operator	6	23,000	138,000	baht/month
Water truck	1	9,000	9,000	baht/month
Grader operator	1	10,000	10,000	baht/month
Bulldozer operator	1	10,000	10,000	baht/month
Foreman	5	9,000	45,000	baht/month
Laborers	15	9,000	135,000	baht/month
Total labor cost			660,000	baht/month
			8,580,000	baht/year
			3.58	baht/ton

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Hauling cost

Caterpillar 772E	6	Unit	Fuel =	3,360	Baht/hr
Price	฿18,000,000	Unit	Lubrication =	5,040	Baht/hr
Fuel consumption	28	l/hr	Tyres =	1,106	Baht/hr
Tyres	234,000	Baht	Repair parts =	691	Baht/hr
Lubrication (25% of Fuel)	25%		Wear parts =	540	Baht/hr
Net power consumable	80%		Major Overhaul =	3,240	Baht/hr
			Total Hualing Cost =	13,977	Baht/hr
				13.98	Baht/ton

Loading cost

Loader (CAT 349D)	2	Unit	Fuel =	2,280	Baht/hr
Price	฿10,500,000	Unit	Lubrication =	1,140.00	Baht/hr
Fuel consumption	46	l/hr	Tyres =	25	Baht/hr
Tyres	157,500	Baht	Repair parts =	126	Baht/hr
Lubrication (25% of Fuel)	25%		Wear parts =	105	Baht/hr
Net power consumable	100%		Major Overhaul =	630	Baht/hr
			Total loading Cost =	4,306	Baht/hr
				4.31	Baht/ton

Drilling cost

Track Drills (CAT MD 5050)	2	Unit	Fuel =	1,817	Baht/hr
Price	฿14,000,000		Lubrication =	908	Baht/hr
Enine (Rock Drill HPR4519)	128	kW	Tyres =	15	Baht/hr
Tyres	93,000	Baht	Repair parts =	168	Baht/hr
Lubrication (25% of Fuel)	25%		Wear parts =	140	Baht/hr
Net power consumable	95%		Major Overhaul =	840	Baht/hr
			Total Drilling Cost =	3,888	Baht/hr
				3.89	Baht/ton

Blasting cost

Blasting material Cost			Explosive cost	3,813	Baht/hole
Granite material	405	ton/hole	Booster charge	95	Baht/hole
Bulk Emulsion	153	Kg/hole	แก๊ป	250	Baht/hole
Booster charge	1	Kg/hole	Other	5	Baht/hole
แก๊ป	1	unit/hole	Total Blasting Cost =	4,162.5	Baht/hole
Explosive element price				9.23	Baht/ton
Bulk Emulsion price	25	Baht/kg			
Booster charge	95	Baht/kg			
แก๊ป	250	Baht/Unit			

Support mine equipment cost

Front end loader (Cat 950G)	2.00	Unit	Fuel =	125.00	Baht/hr
Price	฿ 7,500,000.00	Unit	Lubrication =	62.50	Baht/hr
Fuel consumption	5.00	l/hr	Tyres =	76.78	Baht/hr
Tyres	97,500.00	Baht	Repair parts =	45.00	Baht/hr
Lubrication (25% of Fuel)	25.00%		Wear parts =	37.50	Baht/hr
Net power consumable	50.00%		Major Overhaul =	225.00	Baht/hr
			Total Hualing Cost =	571.78	Baht/hr
				0.57	Baht/ton

Support mine equipment cost

Bulldozer	1.00	Unit	Fuel =	375.00	Baht/hr
Price	฿ 9,700,000.00	Unit	Lubrication =	93.75	Baht/hr
Fuel consumption	20.00	l/hr	Tyres =	74.48	Baht/hr
Tyres	126,100.00	Baht	Repair parts =	43.65	Baht/hr
Lubrication (25% of Fuel)	25.0%		Wear parts =	36.38	Baht/hr
Net power consumable	75.0%		Major Overhaul =	218.25	Baht/hr
			Total Hualing Cost =	841.50	Baht/hr
				0.84	Baht/ton

Support mine equipment cost

Greader (Caterpillar 14 E)	1.00	Unit	Fuel =	375.00	Baht/hr
Price	฿ 1,200,000.00	Unit	Lubrication =	93.75	Baht/hr
Fuel consumption	20.00	l/hr	Tyres =	9.21	Baht/hr
Tyres	15,600.00	Baht	Repair parts =	5.40	Baht/hr
Lubrication (25% of Fuel)	25.00%		Wear parts =	4.50	Baht/hr
Net power consumable	75.00%		Major Overhaul =	27.00	Baht/hr
			Total Hualing Cost =	514.86	Baht/hr
				0.51	Baht/ton

Support mine equipment cost

Pickup	4.00	Unit	Fuel =	250.00	Baht/hr
Price	฿ 1,000,000.00	Unit	Lubrication =	250.00	Baht/hr
Fuel consumption	5.00	l/hr	Tyres =	20.48	Baht/hr
Tyres	13,000.00	Baht	Repair parts =	12.00	Baht/hr
Lubrication (25% of Fuel)	25.00%		Wear parts =	10.00	Baht/hr
Net power consumable	50.00%		Major Overhaul =	60.00	Baht/hr
			Total Hualing Cost =	602.48	Baht/hr
				0.60	Baht/ton

Support mine equipment cost

Fuel Truck	1.00	Unit	Fuel =	12.50	Baht/hr
Price	฿ 651,000.00	Unit	Lubrication =	3.13	Baht/hr
Fuel consumption	5.00	l/hr	Tyres =	0.67	Baht/hr
Tyres	8,463.00	Baht	Repair parts =	0.39	Baht/hr
Lubrication (25% of Fuel)	25.00%		Wear parts =	0.33	Baht/hr
Net power consumable	10.00%		Major Overhaul =	1.95	Baht/hr
			Total Hualing Cost =	18.96	Baht/hr
				0.02	Baht/ton

Support mine equipment cost

Water truck	1.00	Unit	Fuel =	25.00	Baht/hr
Price	฿ 420,000.00	Unit	Lubrication =	6.25	Baht/hr
Fuel consumption	5.00	l/hr	Tyres =	0.86	Baht/hr
Tyres	5,460.00	Baht	Repair parts =	0.50	Baht/hr
Lubrication (25% of Fuel)	25.00%		Wear parts =	0.42	Baht/hr
Net power consumable	20.00%		Major Overhaul =	2.52	Baht/hr
			Total Hualing Cost =	35.55	Baht/hr
				0.04	Baht/ton

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Crushing OPEX cost

Crushing function	Percent	baht/ton
Maintenance cost	44.21%	10.75
Electrical cost	34.37%	8.36
Laborers	21.43%	5.21
Total crushing OPEX cost		24.32

Electrical cost

No	Equipment	Model	Power (kW)	Qty	Unit Price (baht)	Electical Cost (Baht/hr)
A1	Vibrating feeder	F5X1360	30.00	1	1,541,640	108.00
A2	Jaw crusher	PEW1100	185.00	1	7,272,750	666.00
A3	Vibrating feeder	ZSW200x12	2.2x2	2	191,250	216.00
A4	Vibrating feeder	S5X2760-2	30.00	1	1,692,750	108.00
A5	Cone crusher	GST250(S2)	220.00	1	8,917,890	792.00
A6	Cone crusher	HST259(S3)	220.00	1	8,917,890	792.00
A7	Vibrating screen	S5X2760-2	30.00	2	1,692,750	216.00
A8	Vibrating screen	S5X2160-3	30.00	1	1,627,890	108.00
A9	Vibrating screen	S5X2160-2	22.00	1	1,281,750	79.20
B1	Belt conveyor	B1200-30m	22.00	1	797,250	79.20
B2	Belt conveyor	B1200-22/4	30.00	1	1,701,750	108.00
B3	Belt conveyor	B1400-12/3	30.00	1	1,537,500	108.00
B4	Belt conveyor	B1000-10/4	11.00	1	1,171,140	39.60
B5	Belt conveyor	B1000-10/2	7.50	1	937,890	27.00
B6	Belt conveyor	B650-20m	5.50	4	306,750	79.20
B7	Belt conveyor	B1000-10/3	15.00	1	973,890	54.00
B8	Belt conveyor	B800-22m	7.50	1	415,500	27.00
B9	Belt conveyor	B800-22m	7.50	1	415,500	27.00
B10	Belt conveyor	B500-20m	2.20	1	279,750	7.92
B11	Belt conveyor	B500-20m	3.00	1	279,750	10.80
C1	Hopper	LC6x6m	-	1	17,950	0.00
A10	Dust collector	ZXMC-160-2	22.00	1	1,152,053	79.20
A11	Dust collector	ZXMC-260-2	45.00	1	1,872,400	162.00
A12	Dust collector	ZXMC-380-2	75.00	1	2,736,525	270.00
A13	Magnetic separator	RCYC-12	4.00	1	297,600	14.40
					Baht/hr	4178.52
					baht/ton	8.36

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Crushing plant labor cost

Employee duty	Qty	Personal Salary	Total salary	Unit
Plant Manager	1	90,000	90,000	baht/month
Engineer	2	35,000	70,000	baht/month
Maintenance	16	18,000	288,000	baht/month
Foreman	16	18,000	288,000	baht/month
Security	4	9,000	36,000	baht/month
Front end Loader	2	23,000	46,000	baht/month
Water truck	1	9,000	9,000	baht/month
Laborers	15	9,000	135,000	baht/month
Total labor cost			**962,000**	baht/month
			12,506,000	**baht/year**
			5.21	**baht/ton**

G&A OPEX cost

Employee duty	No. of person	Personnal salary (baht)	Baht/month
Accountant	3	20,000	60,000
Sales	4	18,000	72,000
Marketing	2	18,000	36,000
Enviroment	3	20,000	60,000
Coummunity relations	3	20,000	60,000
Generl officer	8	10,000	80,000
Housekeeper	3	9,000	27,000
Security	2	9,000	18,000
Office consumable per capita	95	1,550	147,250
Other			44,150
Total general and adminstrative cost		baht/year	7,857,200
		baht/ton	3.27

APPENDIX D

Financial model

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	Total	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year
	21	-	1	2	3	4	5	6	7	8	9	10
Annual production	48,481,145	-	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000
Revenues	฿ 15,489.73 M	฿ .00 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M
Capital Cost	-฿ 598.92 M	-฿ 373.59 M										
Royalty	฿ 387.85 M	-	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M
Operating Cost												
Mining Cost	฿ 1,582.34 M	-	฿ 75.91 M	฿ 76.34 M	฿ 77.10 M	฿ 77.90 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M
Processing Cost	฿ 1,311.65 M	-	฿ 58.36 M	฿ 58.99 M	฿ 60.33 M	฿ 62.62 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M
G&A (+5% year 1-5)	฿ 217.89 M	-	฿ 7.86 M	฿ 9.55 M	฿ 9.93 M	฿ 10.33 M	฿ 10.75 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M
Total Operating Cost	฿ 3,111.89 M	-	฿ 142.13 M	฿ 144.88 M	฿ 147.37 M	฿ 150.85 M	฿ 155.72 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M
			฿ .00 M	฿ .00 M	฿ .00 M	฿ .00 M	฿ .00 M					
Net Operating Income	฿ 11,989.99 M	-	฿ 605.47 M	฿ 602.72 M	฿ 600.23 M	฿ 596.75 M	฿ 591.88 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M
Depreciation												
Construction	฿ 23.85 M	-	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M
Equipments	฿ 490.84 M	-	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M	฿ 26.55 M
Total Depreciation	฿ 514.69 M		฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M
Net Income after Depreciation	฿ 11,475.30 M	-	฿ 577.72 M	฿ 574.98 M	฿ 572.49 M	฿ 569.01 M	฿ 564.14 M	฿ 563.69 M	฿ 563.69 M	฿ 563.69 M	฿ 563.69 M	฿ 563.69 M
Tax (30%)	฿ 3,442.59 M	-	฿ 173.32 M	฿ 172.49 M	฿ 171.75 M	฿ 170.70 M	฿ 169.24 M	฿ 169.11 M	฿ 169.11 M	฿ 169.11 M	฿ 169.11 M	฿ 169.11 M
Net Profit After Tax	฿ 8,032.71 M	-	฿ 404.41 M	฿ 402.49 M	฿ 400.74 M	฿ 398.31 M	฿ 394.90 M	฿ 394.59 M	฿ 394.59 M	฿ 394.59 M	฿ 394.59 M	฿ 394.59 M
Add Deprciation	฿ 514.69 M	-	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M	฿ 27.74 M
Net Cash Flow after Tax		-฿ 598.92 M	฿ 432.15 M	฿ 430.23 M	฿ 428.49 M	฿ 426.05 M	฿ 422.64 M	฿ 422.33 M	฿ 422.33 M	฿ 422.33 M	฿ 422.33 M	฿ 422.33 M

		Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
Annual production	ton	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	481,145
Revenues		฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 766.80 M	฿ 153.73 M
Capital Cost		-฿ 225.33 M										
Royalty		฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 19.20 M	฿ 3.85 M
Operating Cost												
Mining Cost		฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 78.74 M	฿ 15.22 M
Processing Cost		฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 66.23 M	฿ 11.70 M
G&A (+5% year 1-5)		฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 11.19 M	฿ 1.58 M
Total Operating Cost		฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 156.16 M	฿ 28.49 M
Net Operating Income		฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 591.44 M	฿ 121.38 M
Depreciation												
Construction		฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ 1.19 M	฿ .00 M
Equipments		฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ 22.53 M	฿ .00 M
Total Depreciation		฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ .00 M
Net Income after Depreciation		฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 567.71 M	฿ 121.38 M
Tax (30%)		฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 170.31 M	฿ 36.41 M
Net Profit After Tax		฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 397.40 M	฿ 84.97 M
Add Depreciation		฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ 23.73 M	฿ .00 M
Net Cash Flow after Tax		฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 421.12 M	฿ 84.97 M