Technical Reports: Coastal Clay Products

Clay Brick Manufacturing Plant

Prepared on Behalf of Phoenix Investments

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1. Executive Summary

To be completed after a review of the draft document.

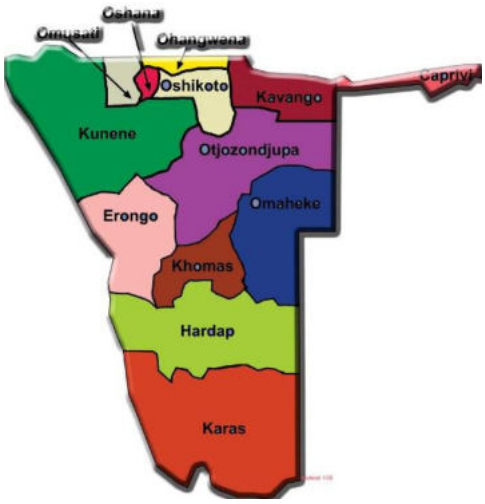
2. Introduction

The Omdel Brick Project was initiated by Phoenix Investments, a Geosciences Exploration, Consulting and Services company registered in Namibia. The company owns 100% of the mineral rights for the Omdel dam area, through EPL 3903 for industrial minerals, namely clay, and is thus uniquely positioned to extract and process clay from the site. The required base infrastructure, such as access to electricity, water and roads to the area assist in making this a viable opportunity in a value added production environment. The project has been named Coastal Clay Products, (CCS), as it will encompass clay brick manufacturing with possible additional products such as handmade quarry tiles and the supply of potting clay to the Namibian pottery industry.

The project is registered with the Ministry of Mines and Energy under an Exclusive Prospecting Licence Number 3903 (EPL 3903). The employment opportunities will provide a much needed boost for the Erongo region while providing quality clay bricks for the greater Erongo region and further afield to neighboring regions.

Technical analysis has been conducted on the clay to determine the suitability of the clay for brick manufacturing purposes as well as clay paving.

2.1. Erongo Region



Namibia consists of 14 Regions with Erongo being centrally placed on the West side of Namibia bordering on the Atlatic ocean to the west, Kunene to the North, Otjozondjupa and Khomas to the East and Hardap to the South.

Erongo is a large contributor to the Namibian GDP. This is achieved primarily through Fishing, Mining Agriculture and Tourism. The GDP has seen fluctuating growth over time however a key economic concern is the level of unemployment. Statistics exist for two definitions of unemployment, those who are actively seeking unemployment, 16,7% of the employable population, December 2012 vs 51% if non job seekers are taken into consideration. Of 25,000 annual school leavers across Namibia it is estimated that only 8,000 will become employed. This will negatively impact the unemployment over time. Given these statistic there should be little shortage of employable labor in the region of Omdel dam.

The Erongo region is home to Walvis Bay and Swakopmund, both situated to the South of Henties Bay and relatively close to Windhoek, situated inland to the East. These are the main economic hubs within reach of Henties Bay and which will form part of the target region for Pheonix Investments. The Erongo region is also home to Namclay, manufacturing in Uis, 125km Nothwest of Henties Bay.

2.2. Brick Making Feasibility

This study has been commissioned to determine the feasibility of developing and commission a Clay Brick manufacturing facility at the Omdel dam site which is 35km to the west of Henties bay. Testing of the clay has been conducted by Cermalab, a credible company with an accredited testing facility,

and found to be suitable for the manufacturing of clay bricks. Multiple sources of information have been used in this study and these include:

- Cermalab Reports
- Research conducted and supplied by Phoenix Investments
- Internet research
- Site visits and interviews with local industry role players

As this document is only a feasibility study some values may require further research in order to ensure that the final detailed values used are as accurate as possible. The full Business Plan, to be completed, will ensure more detailed numbers are used.

2.3. Key Consideration for Business Feasibility Requirements

In order for the business to be viable it has to be able to effectively manage the various business drivers that this project will face. The following is a high level overview of the business drivers and their subsets:

- Capital requirements inclusive of:
  - Identified stakeholder funding
  - Contractual obligations Legal, compliance and negotiations
  - Regulatory compliances such as Air Emissions License and ongoing monitoring requirements
  - Site establishment including connections and supply costs
  - Equipment purchases, construction and commissioning
  - Working capital for a minimum defined period
- Cost of sales
  - Supplier sourcing and negotiations
  - Minimize and control cost of production
  - Define distribution plan to minimize costs
  - Administration and overheads
- Average selling price
  - Sales marketing and distribution costs
  - Ongoing market research
  - Competitive analysis
- Ongoing skills development
  - Training
  - Staff development
- Cash flow and facility management
  - Capital repayment plans
  - Compliance costs
  - Constantly reviewing Supplier agreements
- Regulatory and compliance costs

3. Industry and Market Place Analysis

Review required of research and feedback from industry as to where the industry is and where it is going

3.1. Clay Brick Analysis

Standard brick sizing is considered to be imperial, being 105 x 73 x 222 with variations according to regional breakdown and client demand.

- FBX Engineering standard face bricks
- FBS Face Brick Standard
- FBA Face Brick Aesthetic
- NFX Non-Facing Extra
- NFP Non-Facing Plaster
- Variation in size of the above
- Pavers

Brick sizing is typically:	
Imperial	105 x 73 x 222
Maxis	Variations exist
Quantums	Variations exist
Gems	Variations exist
140 Brick	140 x 75 222

The SANS 207:2007 standard defines certain requirements relating to shape and form, texture and colour and durability for Burnt Clay Masonry Units. Compressive strength is adopted as a measure of durability, achieved through degree of firing achieved. The required compressive strengths for the brick types are defined as well as the testing methodology for compressive strengths are contained within SANS 207:2007.

The test results achieved by Cermalab and presented in their feasibility study indicate that the clay from the slimes is capable of meeting compressive strengths required for all brick types. The types of bricks produced by a plant is dependent on the processes selected to manufacture the bricks with higher value products such as FBS and Pavers requiring very high levels of control and quality management thus necessitating more expensive production equipment and processes.

Table 8: Compressive Strength Table

1	2	3
Class of unit	**Nominal compressive strength** MPa	**Individual compressive strength** MPa min
FBS) FBX) FBA)	 12,0* 17,0	 9,0* 12,5
 NFP) NFX)	3,5* 7,0 10,5* 14,0	3,0* 5,5 7,5* 10,5
* For hand-moulded units.		

3.2. Industry Analysis

The building industry in Namibia has been on a growth path for some time with a large number of key projects being undertaken in the public and private sector. The housing market in Namibia has also come under the spotlight of late with the Government promising to build in excess of 150,000 houses over the next 5 to 10 years in order to reduce the backlog of housing. The bulk of this housing will be in the entry level segment.

According to Market Research.com, as announced in their Namibia Infrastructure Report Q2 2014, Namibia has seen a significant boost to the construction industry with a large increase in building plans passed in 2013 and a prediction of 16,3% year on year growth expected for 2014 in value terms. According to the report, the 10 year growth prospects are unlikely to be as good given that

there is a short term Government driven stimulus. Long term forecasts can however be sustained if energy related projects are brought to the table as well as large private investments are made to unlock potential.

Localized development in the Erongo region is leading the overall index due to ongoing developments in the mining sector, enlargement of the Walvis Bay Harbour and increases being seen in the tourism industry. Discussions with a number of hardware retailers in the Walvis Bay, and Swakopmund area also indicate an increased volume of building plans being submitted with strong demand for building materials being experienced. Key focus areas in the local construction sector are housing and Leisure industry with private housing taking a lead role. This bodes well for ongoing demand for building materials in general as well as for walling materials.

3.3. Competitor Analysis

3.3.1. Clay brick manufacturers in Namibia

There are only three recognized clay brick manufacturers in Namibia with a combined production capacity of less than 3,000,000 bricks per year. In comparison with South Africa, who produce approximately 1,2 billion bricks per year, this is a very small volume. As a result the most common walling construction material is cement bricks with most construction companies using this building material.

The largest and most active Clay brick manufacturer is Namclay Bricks and Pavers (Pty) Ltd, based in Uis, Erongo Region, who produce a range of clay bricks monthly. According to market intelligence gathered to date it would appear that they have a production capacity in excess of 1,000,000 bricks per month. They produce and sell NFP, NFX, FBA and Pavers. Their pricing ranges from $1.05 for NFP up to $4.00 for Rockface facebricks. They have developed a good reputation in the market and distribute their products around Namibia. This is also the closest clay brick yard to CCP who will produce on site at Omdel. Namclay focus on providing quality products as their marketing strategy and although they are price aware they are not driven by market price.

The next largest clay brick producer is a Chinese owned and operated brick plant in Mariental. This factory produces a relatively low quality plaster brick and is said to produce and sell approximately 700,000 bricks per month. Their market positioning is based on price and do not have a good reputation for quality. The bulk of their market is Windhoek based and also sell into Keetmanshoop.

The remaining facility is based in the North East of Namibia up in the Grootfontein are. Little is known of their product quality, product range or their pricing. They will not be a marketing factor for CCP's as their distance from the main CCP marketing area makes competition unfeasible. Over time it is anticipated that CCP will market and sell products into the Northern and North western region of the county and at this stage the Grootfontein factory will be competition.

3.3.2. Alternative Product Producers

The most popular current walling material is Cement Bricks and these are produced by a number of companies within the immediate Erongo area of Henties Bay, Swakopmund and Walvis Bay. One supplier based in Swakopmund distributes product as far afield as Windhoek which is surprising given the distance of 380km and the cost of transport.

There are a number of producers in the area, two in Henties Bay, Three in Swakopmund and two in Walvis bay. Between these players there are a variation of products with the typical range including:

- Plaster bricks
- Foundation bricks
- Face brick, including colour variations
- Interlocking pavers
- Oversize bricks for single skin construction
- Building blocks of various dimensions

- Hentiebaai – Swakopmund 75km
- Swakopmund - Walvis Bay 35km

Distance between points of interest:

- Emdel Dam – Hentiesbaai 35km

Research indicates that these producers do not typically transport their products outside of their immediate market, the exception being the one Swakopmund producer. The advantage that they have is an intimate knowledge and working relationship of their immediate client base. This may make it difficult to enter a relatively closed market and cognizance of this must be taken into account.

3.4. Product Demand and Pricing

According to investigative visits at three hardware stores in Swakopmund as well as an exploratory meeting held with the Town Engineer in Henties Bay, there is a growing demand for bricks. What was not specified is what portion of the market could be captured by a local producer of quality clay bricks. Most local builders construct housing and local Architects are also specifying cement bricks. The reason for this is a lack of knowledge on the benefits of clay bricks as well as the lack of availability of alternative products.

One of the key issues, well known and understood within the industry, is that there is a constant need to maintain houses and in particular the need to repaint on a regular basis due to constant water penetration. Cement bricks have a very high expansion co-efficient when coming into contact with water and then reduces back to the original size on drying out. This results in continuous fine cracking that breaks the paint barrier resulting in a constant need to repair and repaint houses in areas with

high moisture, either from ground penetration or precipitation from rain or coastal fog. With ground water table being relatively high and the salt content being high along the coast line Architects are

specifying a high Mpa product, typically face brick products to be used up to floor level. This is an attempt to reduce the impact of salt erosion experienced in cement brick products as well as reduce the impact of expansion and contraction due to water penetration. This is clearly a product advantage for clay bricks and one to be exploited.

It is evident that there is a clay face brick market in the area. The existing constraint to this market is that imported face bricks from South Africa have a retail price in excess of $10.00 per unit which immediately reduces market interest. A locally produced quality FBA, Face Brick Aesthetic, will be able to penetrate the market at the proposed pricing

Pricing will be determined in conjunction with the market in order to be competitive and in order to be able to compete favorably against Namclay to ensure a viable market. Visits have been made to a number of building supply merchants as well as to one or two cement brick producers to ensure that the market pricing is well understood. Feedback as received from market players with regards to requirements from suppliers are listed as:

- Product availability
- Product quality
- Price

Brick pricing is made up of a number factors the most important from a marketing perspective is the landed price to the consumer. This is made up of a yard price, selling price at the factory, and the transport price, cost of delivering the product to the client site.

Table 1: Proposed brick pricing

Swakopmund Pricing				
Product	**Yard**	**Tpt**	**VAT**	**Delivered**
NFP	1,100.00	376.90	221.54	1,698.44
NFX	2,100.00	377.90	371.69	2,849.59
FBA	2,400.00	378.90	416.84	3,195.74
Paver	2,750.00	379.90	469.49	3,599.39

The Average Selling Price, (ASP), is important to understand in context of determining the factory's profitability. The table below provides an overview of the anticipated ASP given a prediction of the product mix expected to be sold.

Table 7: Product mix and ASP

Product Type	**$/1,000**	**% Sales**	**Weighted**
NFP	1100	60%	660
NFX	2100	10%	210
FBA	2400	20%	480
Paver	2750	10%	275
		100%	**1625**

The ASP above provides a healthy operating margin at the factory level with good contributions from which to cover overheads as well as returns to investors and shareholders.

4. Marketing Plan

As a new entrant to the local market CCP will focus on a visibility and education campaign in order to ensure that key stakeholders in the area are aware of the products as well their benefits. Each market

segment identified may require a slightly different marketing approach and the intention is to develop the marketing message to allow for flexibility in its delivery. Membership to the Clay brick Association of South Africa, ClayBrick.org, will be undertaken. This will provide access to market research, marketing material, training material and marketing literature ready for use across the identified market segments.

4.1. Brick Market Segments

The Target market can be divided into four key sectors, Public sector formal building, Private sector formal building, Private sector informal building and Brick Resellers and Specifiers. The Private sector informal segment is predominantly small Do-It-Yourself, (DIY), alterations and minor improvements. Each one of the sectors has specific elements and require a different marketing approach.

4.1.1. Public Sector

Public sector construction is generally aimed at large infrastructure development projects such as:

- Government buildings
- Public health
- Education
- Police and transportation
- Low cost housing

The above list is non-exhaustive. These projects tend to be large, are done over a period of time and typically backed by Government construction guarantees. Even though these are Government projects typically with Public Works Departments as the end client, they are constructed by Private companies. Lead times from investigation/feasibility through top tender and finally to breaking ground on these projects could take years and are subject to available budgets.

4.1.2. Private Sector Formal

Private sector formal construction is made up of a number of stakeholders namely: Large national construction companies such as Grinnaker/LTA, Basil Read, Stefanutti Stocks etc. they are put together with

- Small to medium size companies, these tend to be more regionally based
- Small to medium size builders, Kimberley and immediate surrounds
- Small builders only local

Public sector buildings will usually be constructed by the large national companies as well as by small to medium sized regional companies. Larger private developments such as commercial and retail construction projects will also be completed by these construction companies with smaller projects being taken on by regional or local companies.

4.1.3. Private Sector Informal

This sector is often referred to as the “Bakkie Brigade” and also encompasses the private DIY sector and tends to focus on very small once off type projects with low volumes. This sector is not to be

dismissed as it will account for a fair portion of the market during slowdowns in the building cycles that afflict the construction sector from time to time. Many home owners are often not in a position to buy and sell on a regular basis and focus on small upgrades on an ongoing basis.

4.1.4. Brick Resellers & Specifiers

The Brick Reseller sector of the market consists of National hardware chains, regional and/or local hardware stores and dedicated brick resellers. Although selling of bricks through resellers dilutes the

Average Selling Price, (ASP), achieved by the brick manufacturers they often have established relationships and offer a personalized service with credit facilities.

Specifiers as mentioned earlier are typically members of the project Professional team such as Architects and Quantity Surveyors. Architects once convinced of the benefits of one product over another play a critical role in the dissemination of the knowledge and the benefits derived from the use of the product. Where clay bricks have an advantage of competing products it will be necessary to educate and inform this sector about the benefits, short, medium and long term. Once clay products are specified by the professional team it bolsters the future sales of the product and reduces the effort required to penetrate the market.

4.2. Identifying and Marketing to Market Segments

Each market sector identified above will require a variation in approach to identifying opportunities as well as the marketing effort required. The matrix below provides an insight to the overall marketing approach that will be adopted by DB's:

Table 5: Marketing Matrix

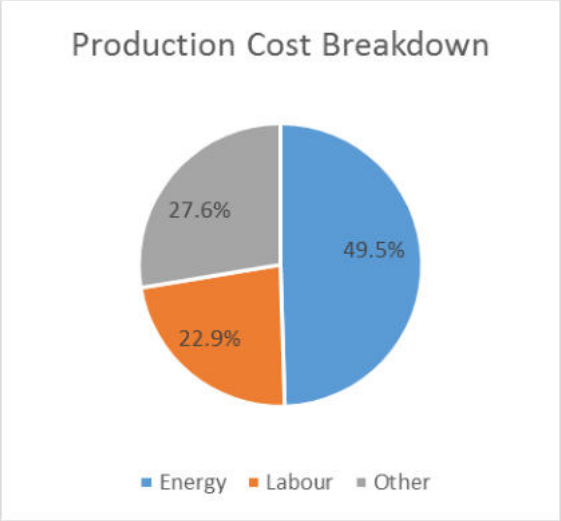
Sector	Opportunity Identification	Marketing Message	Delivery Mechanism
Public Sector	• Feasibility studies • LED Plans • Tender bulletins • Public announcements	• Industry driven • Specification by Architects • Low ability to influence	• Tender response • Meetings
Private Sector Formal	• Tender requests • Public media and announcements • Cold calls • Relationship management • Word of mouth	• Marketing material from Claybrick.org • Benefits of clay bricks • Service levels	• Tender responses • Advertising in local and regional media • Word of mouth • Meetings
Private Sector Informal	• Walk-in • Word of mouth	• Benefits of clay bricks • Service • Price	• Advertising • Word of mouth
Brick Resellers	• Business listings • National chains • Relationships • Word of mouth • Cold Calling	• Service • Pricing • Benefits of clay bricks • Research to back up marketing message	• Advertising • Cold calls • Relationships • Benefit analysis

As per the marketing matrix there is a strong need identified for establishing the CCP brand as well as developing relationships. Although a little has been said with regards to targeting the professional role players such as Developers, Architects and Quantity Surveyors, it is important to re-iterate their importance. These are an important target market. Not being the end user of the product and not linked directly to the sale of the bricks these role players will specify walling materials and need to be marketed to with the following information:

- Benefits of clay bricks over alternative walling systems
- Life cycle energy consumption
- Life cycle costs
- Low energy consumption of the selected production methodology
- Environmental benefits utilizing tools such as Green Star and the role of low energy bricks

5. Operational and Technical Plan

Clay brick manufacturing can be broken down into two key factors namely material handling and energy management.



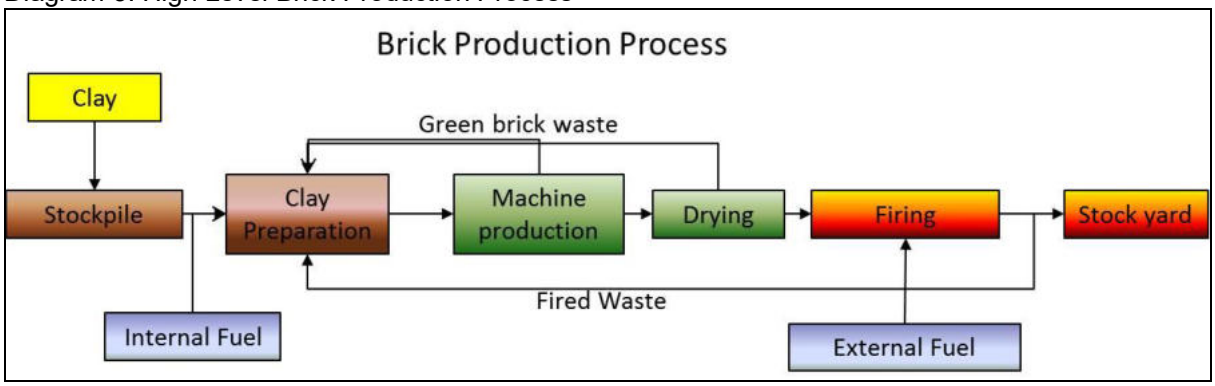
Material handling from the mining and preparation of the clay, moving of bricks in their various states of production through to customer delivery requires constant management. Clay and clay products by nature are heavy and thus effort and costs escalate if not managed correctly.

Energy costs consist primarily of Firing Energy, Fuel energy used in material handling and electricity to drive the production machinery

Labour is a key component and although it is possible to reduce labour through automation it is only feasible to do so above certain volumes or where high end products with larger margins are produced. Given the environment that CCP is going to operate as well as the product mix, automation is not feasible.

The general process used to produce clay bricks does vary significantly regardless of manual labour or if highly automated. The diagram below is a high level overview of the production process used by clay brick manufacturers globally. Minor variations do occur according to plant layouts and technologies employed however these changes can still be classified as per the diagram below.

Diagram 3: High Level Brick Production Process



The key steps in the process do not change significantly however the detail of how these are performed will change dramatically dependent on the technology applied, product suite produced and the level of automation applied. In keeping with the stated objectives of this project a combination of business feasibility and job creation must be achieved in order to be classified as successful.

The primary products to be manufactured by DB are Clay Bricks as per the above high level process. Any further products identified will require a separate process and these will be discussed further on in the BP.

5.1. Technical Analysis

5.1.1. Mining and Stockpiling

There are two options for the clay extraction namely self-extraction or contracted out. In order to reduce the overall capital requirements at start-up the preferred approach is to make use of a contractor to remove the raw material from the Omdel dam and create stock piles. The stock piles allow for continuous operation and a minimum of one month's stockpile should be in place at any point in time in the event of machinery breakdown or adverse extraction conditions. Stockpiles should be allowed to "rest" for a period in order to allow for some oxidation of the clay. Given the relatively "young age" of the Omdel deposits this may not be a requirement but will be assessed once operations begin.

It is recommended that contractors be used by CCP given that it will be more economical to do mass extraction on a regular basis. This will also reduce risk of removing as and when required due to unpredictable rainfall in the area. A minimum of 3 months stock pile is recommended under these circumstances to cater for unexpected events and to aid production planning.

The following are considerations for the material extraction:

- The winning of the material and stockpiles must be considered during the preparation of the Environmental Management Plan, (EMP), if required according the mineral rights processes in Namibia
    - Roads used
    - Waste generated from removal of vegetation
    - Stock pile area and water run off
    - Dust suppression at extraction, on roads and in the stock pile area
- 2.2 m^3 of clay is required per 1,000 bricks
- Access to the clay must be planned

    - Mine from the edges of dam with excavator
    - Dry material to be mined in layers in order to allow lower material to reduce moisture
    - Vegetation to be removed and screened out during mining process
- Stock piles are laid down in a manner that improves clay mix
    - Stock piles are layered to create a homogeneous mix
    - Stock piles are sloped to allow for water runoff
    - Height of stock piles lower than 4 meters at the face to prevent collapsing
    - Stockpile face to be close to feeder bin to reduce handling distance

Further analysis of mining requirements will determine if self-extraction or outsourced mining is the best option.

5.1.2. Raw Material Preparation

The generic process for clay preparation is a combination of lump breaking, crushing and grinding/refining in order to produce a determined maximum particle size. The condition of the raw material will play a significant role in determining the final process. The Omdel dam consists of very fine material near the dam wall with gradually increasing size of material moving further back, over 1 km back from the wall. These deposits have been laid down over a period of 30 years since the dam construction in 1984. Given the fineness of the material it will be beneficial to mix in a percentage of coarser material from the upper reaches of the dam to increase the average particle size.

Given the initial fineness of the material from the silting process of the dam it is anticipated that the focus will be on ensuring that lumps are removed and not on pure crushing as would be required when strip-mining embedded clay. The key preparation processes from the stockpiles are as follows:

- Scoop buckets from stockpile with Front End Loader
    - Removed from sequence of stock piles
        - Use up one stockpile
        - Move to next in line
    - Layers within stockpile create homogeneous mix
- Drop clay into feeder hopper
    - Hopper capacity to be defined during detailed review
    - Feeder belt under hopper driven by electric motor
- Feed drops onto conveyer belt
- Conveyer belt carries clay to crusher/refiner
    - Require input from detailed analysis to determine best equipment
- Crusher reduces lumps in clay to workable sizing
    - Maximum particle size <2mm
    - Options for crushers are:
        - Hammer mill
        - Hazemag
        - Chain crusher
        - Pan mill (wet or dry)
- Crusher output goes to a constant feed hopper
- Constant feed hopper set according to production volume requirements
    - Clay drawn from hopper by constant feed belt
    - Belt driven by electric motor
- Constant feed clay is dropped onto conveyer belt

- Internal fuel is dropped onto constant feed conveyer belt
    - Internal fuel is picked up from stock pile by Front End Loader
    - Internal fuel is loaded into a feed hopper
    - Constant feed is drawn off by motor driven belt

    - Feed rate is determined according to clay feed rate
    - Coal feed conveyer belt drops coal onto clay constant feed belt
- Combined clay and coal is dropped into pre-mixer
    - Brick production method extrusion vs pressing will determine if pre-mixer is required
        - Pre-mixer will benefit extrusion
        - Pressing does not require pre-mixing
- Water is added into pre-mixer
    - Moisture content is determined by brick production mechanism
        - Brick press uses lower moister content
        - Extrusion requirement determined by Solid/Perforated requirement
- Green mix drops onto conveyer belt and transported to main mixer
- Samples of green mix are taken and tested for carbon content
    - Required for control in VSBK
    - Coal feed is upped/reduced based on regular results
- Main mixer used to feed the brick production process
    - Additional water added as required

Key to the clay preparation process is the removal of organic material. The decision as to how to treat organic material will be made once a full assessment has been made on the nature and volume of the plant materials in the extracted clay.

5.1.3. Green Brick Making

A key consideration still under investigation is brick pressing versus brick extrusion as the preferred machine production method. This decision can only be taken once a full investigation into brick press feasibility has been conducted. At present no large scale brick press operations are in production in South Africa however there are agents for brick press suppliers and they will be engaged moving forward. Advantages of brick press over extrusion are:

1. Capital outlay can be staggered with growth
2. Flexibility in volume production and shapes produced
3. Lower water consumption during clay preparation
4. Lower electricity consumption per brick

The major concern for is the lack of fully functional brick yards that operate on a brick press basis. In light of this the processes for both production mechanisms are described below:

Extrusion process

The extrusion process is based on a technology that is generally the preferred technology in South Africa. It is the most widely used and best supported. The key process is as follows:

- Top mixer - clay is fed via conveyer belt from the output of the clay prep process
    - Blades drive the clay towards the extruder
    - Final water is added subject to requirements
- Top mixer drives clay into the sealing auger
    - A plug is created preventing air from entering vacuum chamber
    - Vacuum chamber removes air via vacuum pump
- Clay is driven into extruder through auger sets
- Column of clay is pushed out shaper cap
    - Shaper cap is set to size of required bricks
    - Different brick sizing require different shaper caps
    - Lubrication ring inside extrude reducing friction
- Clay column has length and width of brick
- Column carried on a conveyer
- Column is cut into brick height, typically 75mm by wire cutter

    - Push through cutter or;
    - Circular cutter
- Cut bricks move onto off-setting conveyer belt
- Bricks are picked up from the belt and packed on drying palettes

Brick press process

- Press feeder - clay is fed via conveyer belt from the output of the clay prep process
- Drying/moister adding as required
- Conveyer belt feeds to press feeder
- Volumes as required per press is fed into moulds
- Press compresses brick shapes
- Pressed bricks are pushed onto off-setting belt
- Pressed bricks are packed onto drying palettes

Press shapes and sizes can be adjusted by changing the mould shapes and feed volumes. The change over time and effort is significantly less than that required to change an extruder. In an extruder plant the shaper cap must be changed as well as cutter adjustments need to be made to accommodate the brick sizes. Discussions have been held with Strom Brick Making Machinery who produce and sell brick presses. The agent is based in Bloemfontein and support and back up can be provided from there.

5.1.4. Drying of Green Bricks

The most common drying practice applied in South Africa is air drying as assisted drying requires additional energy. DB will make use of air drying during the commissioning phase of the plant while investigating assisted drying as a possibility in later years. Bricks produced using extrusion will have between 17 and 20% moisture whereas brick press will have between 8 and 10% moisture.

The key process for natural drying is as follows:

- Green bricks are packed onto drying palettes from the off-setting belt
- Palettes are picked up by forklift/tractor with fork attachments
- Palettes are put into hack lines where they are open to the elements
    - Forklifts are uneconomical over longer distances
    - Make use of tractors with forklift attachments or:
    - Tractor and trailer to carry multiple palettes
- Plastic is set up to cover hack lines in the event of rain
- Moisture content is regularly monitored
- Dry bricks down to <5% moisture
- Transport dry green bricks from hack lines to VSBK

It is anticipated that the drying time will be between 3 and 5 weeks if bricks are extruded and this will reduce to half the time frame if brick presses are used. The intention is to conduct research into a number of alternative drying mechanisms that will speed up the drying process and reduce the operational risks of unassisted drying. The operational risks associated with unassisted drying are as follows:

1. Exposure to rain – unfired bricks sustain damage when exposed to rain. This increases drying losses
2. Working capital – longer drying time translates to more green bricks in the hack lines.
    a. Green bricks account for approximately 70% of brick value
    b. Higher volumes require higher Work in Progress (WIP
3. Reduced production flexibility due to lead times

Over time it will be of interest to reduce drying time and thus improve working capital required as well as reducing the business risk.

5.1.5. Firing of Bricks

The VSBK is a continuous firing process which requires 24 hour production 365 days per year and will be operated in shifts. The process once fully stabilized, which takes approximately 4 weeks from start-up is as follows:

- Bricks are transported to the VSBK from the hack lines
- Raise bricks to the platform height
    - Forklift is required to move palettes of dry green bricks
    - Forklift lifts palettes onto hoist deck
    - Hoist deck lifts palettes to platform deck
- Move bricks from Platform hoist to VSBK shafts
    - Trolley jack with wheels
    - Moved by hand
- Pack bricks into VSBK shaft by hand
    - Defined stacking pattern is used
    - External fuel is added in at this stage
        - Predetermined volume of coal per batch loaded
        - Coal is weighed per batch
- Fired bricks are unloaded at bottom of shaft
    - Manual handling of trolley below shaft and hoisted by
    - Hydraulic unloading mechanism in shaft pit
    - Unloading time frames are determined by shaft temperature
    - Batches are unloaded as per top loaded
- Bricks stand on trolley below shaft and cool down
- Fired bricks are sorted and packed onto palettes ready for dispatch area

The firing process is closely monitored with the aid of temperature sensors and these are what are used to determine the firing curve for each shaft individually.

5.2. Expected Plant Design and Capacity

The plant will be designed with a maximum initial capacity of 1,000,000 bricks per month. This can be added to at a later stage dependent on the market demand. Clay preparation will be designed for greater capacity as this will have minimal impact upfront and will allow for greater volumes as required. The following table indicates the initial design capacity and upper end volumes that can be achieved with current technology selection and/or flexibility to add volumes capacity.

Table 4 Plant planning capacity

Plant Volume Capacity Calculation	
Days per month	20
Production hrs per day	7
Tons per 1,000	1.8

	Monthly	Daily	Hourly	Tons/hour
Brick Production	1,080,000	54,000	7,714	14
Clay Prep x 3	3,240,000	162,000	23,143	42
Extrusion/Press x 2	2,160,000	108,000	15,429	28

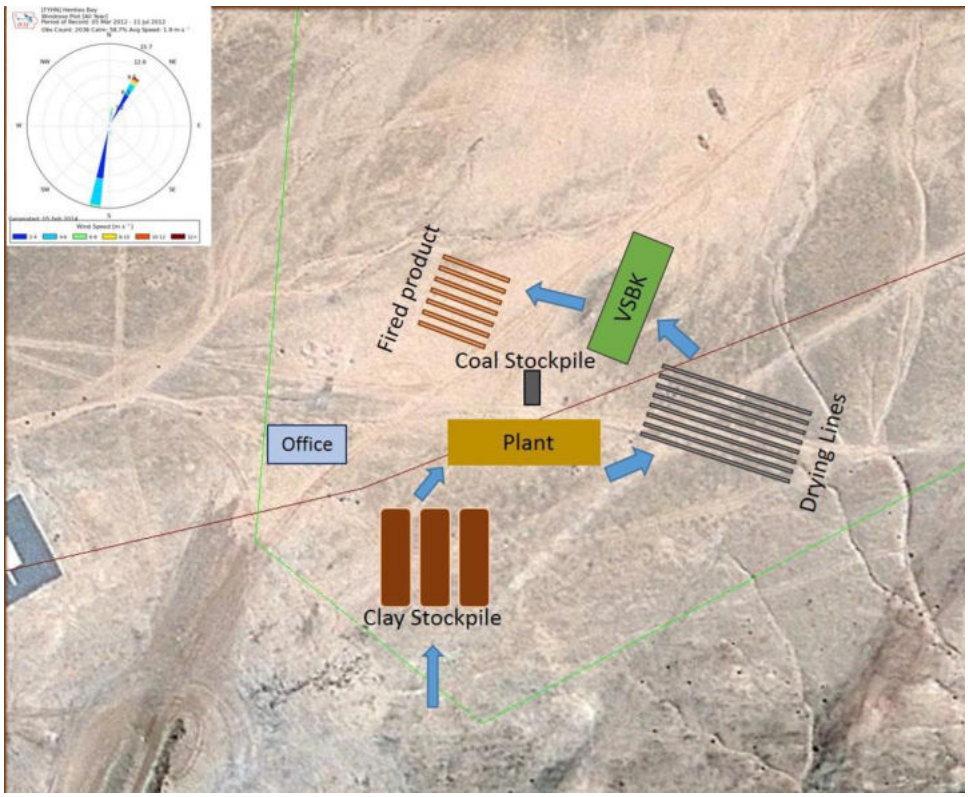
- Brick extrusion is not a flexible volume mechanism and volumes can only be increased by increasing operational time once the machine capacity is reached
- Brick press volumes can be increased by adding additional presses in parallel to original production capacity

- Clay preparation volumes can create bottle necks in the production process if under specified.

5.2.1. Plant Layout & Process Flow

IN order to manage the flow of material through to fired brick product plant layout has been defined in order to prevent cross flow of materials. This will allow for a continuous flow from clay stockpiles through to the finished product. As indicated is diagram 3 above there is a universal process flow that has been adopted for CCP.

Diagram 4: Proposed plant layout and material process flow



The plant is positioned to the North of Omdel dam taking the predominant wind directions into account, being NNE and Southerly. The VSBK is aligned according to the prevailing wind direction so as to reduce the impact of wind blowing directly into the shaft opening. A detailed overview of the production process is indicated in diagram xx below and indicates the management of the clay preparation process.

Diagram 5: Clay Preparation Process

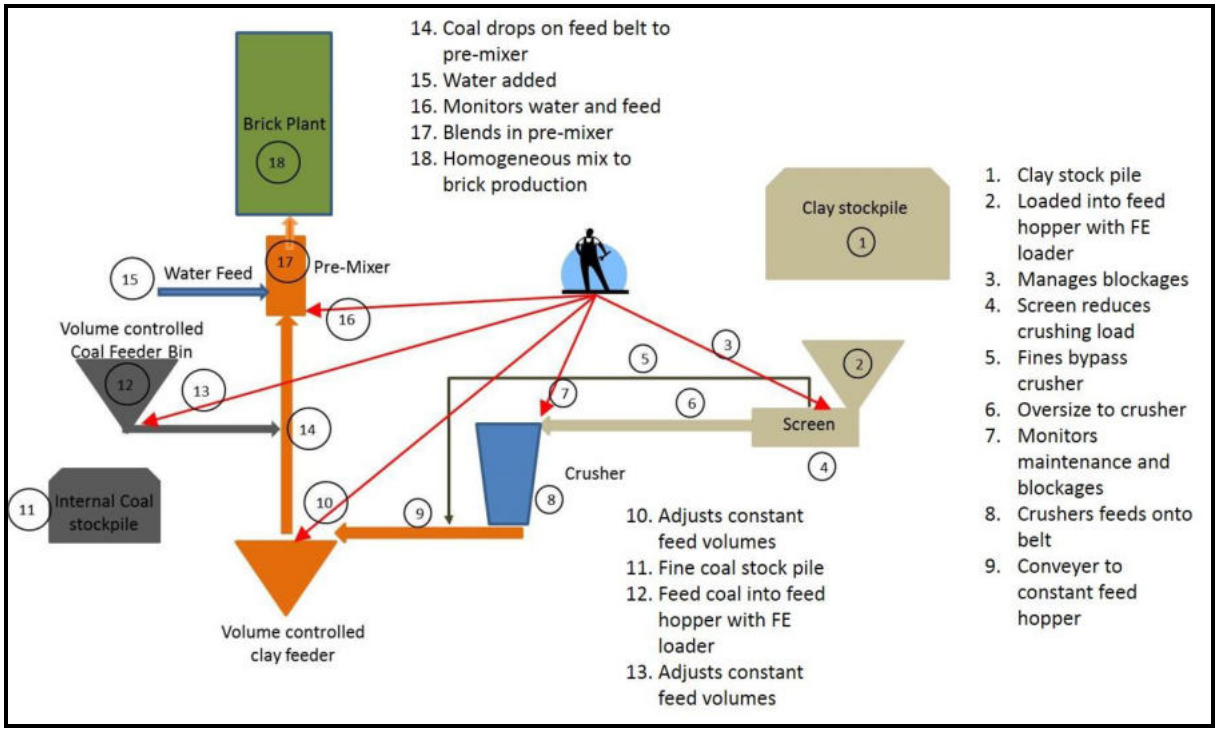
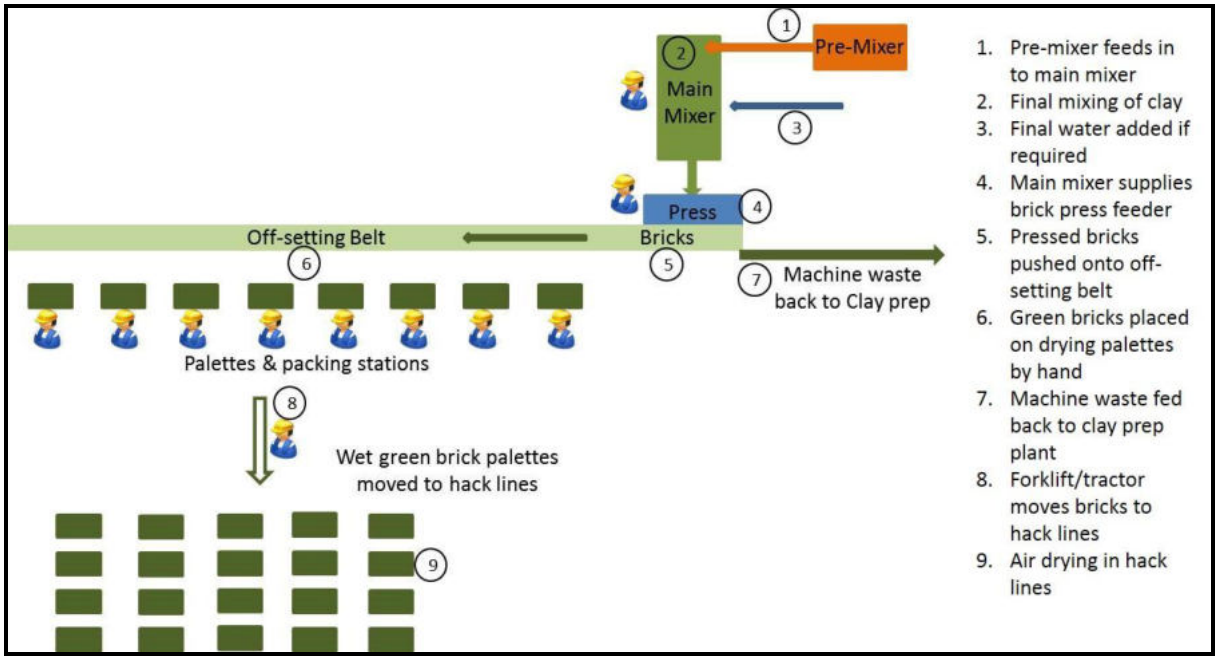


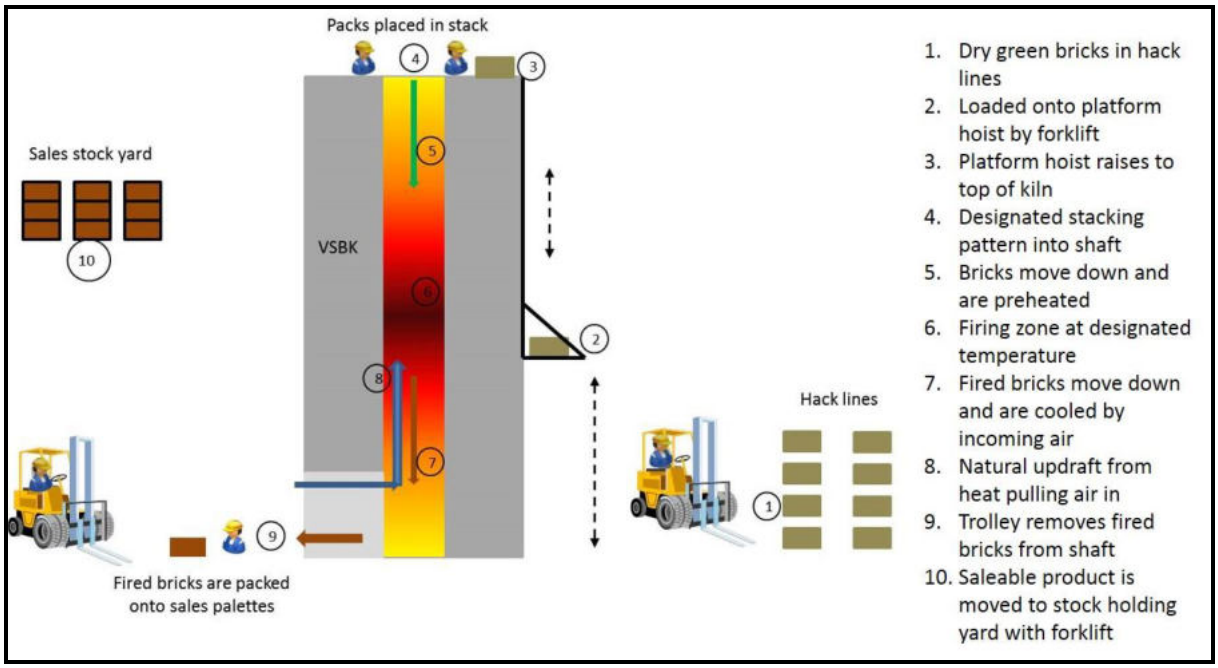
Diagram 6: Brick production Layout & Operation



The brick production process is laid out as if for a brick press. Where an extruder is used then the Press, step 4, is replaced by the extruder and an inline cutter. The balance of the process is the followed as per the diagram above.

The Vertical Shaft Brick Kiln is a continuous firing process making use of a counter current principle reutilizing heat energy from the burning coal to pre-heat bricks coming down the shaft. This removes the final moisture from the green bricks and slowly raises the temperature of the bricks so as to avoid thermal shock. The bricks below the firing zone are cooled down by the air sucked in at the bottom of the shaft. This is also a controlled cool down cycle to prevent thermal shock as the bricks cool down to ambient temperature. The temperature in the firing zone is controlled through the adding or reducing the external coal.

Diagram 7: VSBK Operational Overview



5.2.2. Capital Required to Commission and Start-up

Staring up a clay brick manufacturing plant would typically require a long lead time due to various statutory requirements such as mining licenses and other regulatory approvals. In the case of CCP the Omdel dam is not a mining site, the removal of silt will an exercise to rehabilitate the dam and increase its carrying capacity with commensurate benefits to the surround area. This will reduce the timeline from project initiation through to full production.

The anticipated timeframe from project initiation through to production start is 13 months and a total capital required to achieve this is $21,577,000. This amount includes the first month's production volume prior to going live as well as the first operational month's production costs. Allowance has been made for the recruitment and training of staff critical to the operation of the VSBK. The VSBK will be the first of its kind in Namibia and the training of key staff will have to be facilitated in South Africa at an operational VSBK. It is anticipated that a Production manager will have to be hired in on contract until such time as local people can be fully trained to take on this role.

	Plant Commissiong Cost & Timeline														
	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	1	$21,576,927
	Seed Capital (4 months)														$990,000
Corporate Governance	$15,000														$15,000
Plant Option Finalisation		$100,000													$100,000
Plant Layout & Design			$125,000												$125,000
Supplier negotiations			$0												$0
Road preparation			$200,000												$200,000
Electricity Connection			$300,000												$300,000
Site establishment			$250,000												$250,000
				Plant Establishment Timeframe (7 months)							Commissioning & Start (3 months)			Production	$19,950,000
Plant Equipment Purchase				$3,000,000	$3,000,000										$6,000,000
Roof Construction					$900,000	$900,000									$1,800,000
Electrical Room Set-up					$750,000	$750,000									$1,500,000
Civil Works						$500,000	$500,000	$300,000							$1,300,000
VSBK Construction						$360,000	$720,000	$900,000	$900,000	$720,000					$3,600,000
Mobile Equipment						$900,000			$800,000						$1,700,000
Recruiting & Training							$100,000	$150,000	$150,000	$150,000					$550,000
Equipment Delivery & set up									$300,000	$300,000					$600,000
Clay Extraction									$2,000,000						$2,000,000
Plant Commissioning											$400,000	$500,000			$900,000
Production Start up													$291,087	$345,840	$636,927

It may be possible to reduce the capital cost requirements by sourcing good second hand equipment which will also reduce the payback period for the various sales scenarios developed in the financial business case.

5.3. Plant Operations and Job Creation

Omdel Dam is located 105km's away from Swakopmund which is the economic center for the Erongo Region and which is also the anticipated development node along with Walvis Bay. The decision has been taken that it will be necessary to establish a sales and distribution depot in Swakopmund. This will place the customer facing side of the business in the economic hub as well as allow for easier logistics outbound to other regions.

The Plant will be managed and Operated by the Production Manager who will responsible for all elements of the plant including ordering of materials as required. It is anticipated that the employment volumes in the plant will grow to 47 including the Production Manager at a total annual salary value of $1,494,000. Most of the employees for this opportunity will be sourced from Henties Bay and the surrounding area. The bulk of the employment will e for unskilled manual labour and training will be provided as required.

The Depot will add an additional 8 employment opportunities with an anticipated total salary value of $1,075,000 per annum. This will be a substantial boost for the local economy.

Table 8: Employment per Operational Area

Department	Area	Staff Type	Number
Production	Clay Prep	FE Loader Operator	1
		Cleaner/Operator	1
	Machine Production	Machine Operator	1
		Off-Setter	5
		Cleaner	1
	Drying	Forklift Operator	1
	Firing	Shaft Supervisor	3
		Packing In	12
		Unpacking	12
		Forklift Operator	3
	Despatch	Strapper	1
		Forklift Operator	1
	Maintenance	Maintenance Foreman	1
		Maintenance Assistant	1
Administration	Production Manager		1
	General Administration		1
	Sampler & Tester		1
Depot	Reception, Orders & Debtors		1
	Logistics, Despatch & Creditors		1
	Sales		1
	General Management		1
	Despatcher & Security		1
	Forklift operator		1
Logistics	Deliveries from Factory	Driver	1
		Assistant	1
			55

The Production Manager will take charge of all plant operations including HR issues. This position will report in to the General Manager who will be responsible for the Swakpmund Depot as well as the overall business.

6. Infrastructure Requirements & Business Risks

In order to establish the plant at Omdel there are a few critical infrastructure needs that will have to be established and these center on the production requirements namely:

- Access to electricity to run the plant and the site office requirements
  - Nam Water have a substation at the Omdel dam wall
  - Permission is required to tap into the main line
  - Investigation is required to determine substation capacity and output voltages
- Access to water for the brick production
  - Permission required to sink boreholes
  - Storage capacity is to be established to cater for dry spells and possible erratic supply
- Road improvement from Uis road to the production site
  - Trucks will be using the road daily to carry bricks to the sales depot
  - Supplies such as coal and spares will be required on site
- Bulk diesel supply
  - Bulk capacity to cater for 10,000 liters
  - Monthly consumption is estimated at 6,600 liters
  - Resupply timeframe to determine final capacity
  - Planning permissions to be effected

These infrastructure requirements are all determining factors that could result in the project not being feasible. The road improvement is one which can be managed around but not the diesel, water and electricity supply.

The key identified business risk is the size of the market in the immediate vicinity as well as the price competitiveness in the further market areas such as Windhoek, the Capital city, economic and development hub of Namibia. The mitigating factor for this risk is that the current building boom is set

to continue for the short to medium term, 5-10 years and local brick resellers are excited about the prospect of having a local clay brick supplier.

Being able to educate the professionals such as Architects and Quantity Surveyors is an achievable goal and an activity that must commence as soon as funding for the project is secured. Establishing not only credibility but relationships with these key role players is a business imperative and failure to do so will jeopardize the ability to penetrate the market.

7. Financials

Financial modeling of the anticipated costs and carried out over three sales volume scenarios indicate the project will be operationally cash flow positive within three months. This has been done for the sales scenarios as per the table 8 below.

Table 8: Scenario Break Even Analysis

Break Even Analysis			
Monthly Sales volume	**500,000**	**750,000**	**1,000,000**
Cost of Production	706.17	694.19	670.22
ASP	1,625.00	1,625.00	1,625.00

Contribution/1,000	918.83	930.81	954.78
Monthly Production Contribution ($)	459,617.81	698,310.31	954,982.81
Monthly Overheads	-202,810.67	-202,810.67	-202,810.67
Monthly Cash Contribution	256,807.14	495,499.64	752,172.14
Average VAT payment	-35,432.69	-61,033.05	-120,416.54
Average Company Taxation	-34,982.73	-60,151.31	-118,478.20
Net Monthly Cash before Lease/Loans	**186,392**	**374,315**	**513,277**
Months required to repay full investment	**115.6**	**57.6**	**42.0**
Years Required to Repay Full Investment	**9.6**	**4.8**	**3.5**

The calculation to determine the number of months and years to pay back the full investment is based on the upfront $21,577,000 required to establish and commission the plant. Key comments resulting from the analysis are as follows:

- **500,000 Bricks per month**
  - Bricks sold per month will not deliver sufficient monthly cash flow to repay Lease/Repayment costs on a monthly
  - Additional Capital of $6,952520 will be required to finance the project over and above Capex spend
  - Equity investors would be required to make up the bulk of the investment however this may not prove to be feasible
  - Grant funding options will reduce the required capital to be raised via debt and equity
  - Lease costs are considered a business expense and will reduce Income tax Burden as well as monthly VAT payments. This however on its own will not mitigate the shortfall
- **750,000 Bricks per Month**
  - Equity investors are not as critical however it would be beneficial to manage a 50/50 debt to equity finance model in order to bring down the repayment risk
  - Monthly cash flow will cover combined repayments but not leave much upside for investment returns in the first 5 years
- **1,000,000 Bricks per month**
  - Good monthly cash flows will provide reasonable returns particularly if based on a balanced debt to equity ratio

A surprising development that emerged during the financial modeling is the small variation in Cost of Production, (CoP), across the various volumes scenarios. The key reason for this is that energy, which accounts for almost 50% of CoP is based on input per 1,000 bricks. The CoP is calculated on a per 1,000 bricks basis in line with generally accepted cost and pricing mechanisms for the industry.

In mitigation of the financial modeling impact for the 500,000 brick per month scenario, it will be possible to reduce the capital expenditure required. The figures that have been used for a number of Capex elements are for new equipment and it will be possible to source some of this equipment in the second hand markets both locally and in South Africa. Areas where this can be achieved is for brick making equipment such as extruders, clay preparation and material handling equipment such as forklifts etc.

In the event that the final technology decision is in favor of extrusion then this may limit the ability to reduce the Capex required for plant purchase and commissioning. Alternative pricing of brick presses will be sought other than Strom Technica and this may assist in meeting the budget requirements.

Full cash flow projections for the above scenarios have been developed and are attached as Appendixes to this document.

8. Next Steps

The next steps to be taken are the following:

- Determine ability to meet the infrastructure requirements as identified in section 6
    - Get written approvals as required
    - Establish actual costs associated with these
    - Review these costs with the financial cost assumptions
- Determine more concrete evidence for brick and brick equivalents in the target areas
    - Clarify volumes through industry associations
    - Establish meetings with Industry Professionals to gauge initial understanding of the benefits of clay bricks and their willingness to specify clay products subject to availability
    - Further research with regards to market pricing in Windhoek and the logistics costs to determine actual feasibility of selling into the area
- Finalize technology selection based on pricing, funding required and confidence in the production methodology
- Refine the funding model
    - Approach potential investors with the business modeling scenarios and gauge reception to the investment returns
    - Identify possible grant funding opportunities that reduce the need for external funding
    - Review financial returns based on the feedback
- Secure funding and proceed with the implementation of the Business Plan