4. Project Justification and Alternatives

This section provides the justification for the project as well as assessing the feasible open pit layout and processing alternatives. A key consideration in the justification of the project is the economic role that the extraction of the friable sandstone will have in the local and regional economy and the benefits that will result in industry.

4.1 Introduction to Project Justification

Justification of the proposed development is considered under a number of headings within this report. The principal justifications for the project are considered to be:

- the size, extractability and regional significance of the friable sandstone resource;
- the need to optimise the State's resources and to develop a valuable resource that is recognised by the NSW Department of Mineral Resources;
- the relative lack of iron concentrations and induration compared to alternative friable sandstone deposits on the Newnes Plateau (Pecover 1986);
- the range, quality and 'fully graded' characteristics of the quartz sand products able to be produced and marketed;
- the high quality of diagenetic kaolin present in the sandstone as matrix;
- the location of the resource away from densely populated areas and adjacent to established sand quarries and the Clarence Coal Colliery;
- the fact that the site is able to be developed, operated and rehabilitated in an environmentally and commercially sustainable manner;
- the proximity to the existing rail siding providing a direct rail link to off-site processing locations and Sydney Metropolitan area markets and eliminating the need to road haul product off-site with associated transportation impacts;
- the quality and range of industrial minerals and premium quality construction sands able to be derived from downstream processing of the friable sandstone;
- the current and growing regional demand for the full range of industrial mineral and construction material products able to be produced;
- the finite and diminishing availability of alternative sources of premium quality, industrial and (fully graded) construction sands, within the Sydney Region;
- the non-availability of any substantial quantities of equivalent quality **kaolin** within the Sydney Region.

The project is considered further justified by opportunities to:

- optimise the friable sandstone resource by separation, processing and/or beneficiation of individual mineral components, with little or no waste product generated; and

- minimise environmental and social impact by adopting rail transport and off-site processing options, with limited, if any, requirement for settling ponds and tailings disposal.

Alternatives to the proposal need to be considered from the perspective of both the applicant and the industrial minerals and construction materials industries. The alternatives considered within this report relate to:

- planning alternatives considered by NKPL; and

- alternative sources of supply for local and regional markets of sand and kaolin in the long and short term.

Alternatives with respect to secondary , tertiary and quaternary processing of the crushed sandstone will be considered under a separate EIS.

4.2 Regional Significance

The regional significance of the resource has been established by

- the volume and nature of the friable sandstone resource and the quality of constituent quartz and kaolin mineralogy relative to alternative sites on the Newnes Plateau and within the Sydney Basin in general;

- the suitability of the site for open pit development, sandstone extraction, primary processing and stockpiling in terms of site topography and accessibility, sandstone friability and homogeneity, reserves, and available space;

- the location of the site in proximity to rail and markets for downstream processing and sales;

- the long term demand for kaolin and high quality industrial and construction sand products from Sydney, regional, interstate and (potentially) overseas markets;

- the finite nature of major, existing alternative sources of supply (as discussed in Section 4.8.2).

The first two issues are discussed in Section 3 of this EIS and the later issues are discussed below.

4.3 Resource Location

The friable sandstone resource containing kaolin and high quality quartz sands at Newnes junction is a geologically unique resource that cannot be replenished.

Reconnaissance geological exploration for friable sandstone resource areas within the Newnes Plateau was carried out by the NSW Department of Mineral Resources (Recover, 1986).

Detailed interpretation of reverse circulation drill logs by NKPL focussed on the calculation of an "iron factor" based on the recorded density of ferricrete bands (ironstone); on a scale of zero, equals homogenous friable sandstone (devoid of ironstone bands) to 100 which equates to continuous ironstone. Range of the "iron factor" over the Newnes Plateau is from 0 to 40, refer **Figure 4.1**.

Ironstone banding within a friable sandstone resource is an impediment to traditional ripping and dozing open cut mining methods employed on the Newnes Plateau, and in addition, incurs increased processing costs. Furthermore, the multiple stillstands of the water table which have given rise to the ironstone bands reflect a less aggressive chemical weathering regime. Kaolin diagenetically formed under these conditions is usually not of high grade which limits its applications as an industrial mineral.

Traditional construction sand resources within the Sydney Basin are generally devoid of ironstone (Whitehouse and Roy, 2000). On the Newnes Plateau, with the exception of the southern part of the Clarence Sand and Gravel Pit (Boral), all sand extraction pits have an ironfactor of zero. From a total of 80 drill holes within EL 4192 (Newnes Junction) ironstone banding was a rare phenomenon and when encountered, bands were less than 5 cm in thickness.

Although there are no officially designated areas for sand extraction of the Newnes Plateau, Pecover (1986) has expressed the view that extraction of sand within pine forestry land on the plateau could lessen the environmental impact.

Furthermore, pine plantations according to Pecover (1986) would provide effective screening for such operations thereby reducing noise, dust and visual impact Pines could be re-established over re-contoured areas following cessation of sand extraction.

Based upon these assumptions, potential extraction areas for the Newnes Plateau have been identified by Pecover (1986) and it should be stressed that geological modelling through exploration and quality analysis has played no role in the definition of these areas. **Figure 4.1** shows the location of these areas on the Newnes Plateau and the iron factors of these areas. A subsequent report (Department of Planning, 1996) on "Management strategy for mining of sand within the Newnes Plateau" contains a map of the area showing the same areas defined by Pecover (Sites 1-6) as "sites of highest prospectivity".

The iron factor obtained from these areas range from 15 to 40 with an average of 33. According to the results of diagenetic modelling carried out by NKPL on the Newnes Plateau, the zone of highest prospectivity is represented by the areas of past and current friable sandstone exploration where ironstone banding is almost entirely absent with an iron factor close to zero.

Within this narrow zone of high prospectivity, there is an apparent diagenetic trend (**Figure 4.2**) whereby the iron content of the kaolin matrix decreases in a south easterly direction from 3.95% to 1.78% (raw clay) and from 1.54% to 0.66% (beneficiated clay). Concomitant with this decrease, there is an increase in brightness of the kaolin from 50.5% to 71% (raw clay) and 81% to 95% (beneficiated clay); (Kmentoni 1984, a, b, c; 1985).

Increased brightness combined with a lower iron concentration are desirable parameters of the kaolin which enhance its uses as an industrial mineral.

According to the results of diagenetic modelling carried out by NKPL, the Newnes Junction friable sandstone resource located on EL 4192 is ideally situated on the south eastern extreme of this diagenetic trend of chemical weathering. The absence of shale and claystone bands (acting as aquicludes) have reinforced the aggressive leaching conditions which has generated the high grade resource at this locality.

Premium quality kaolin and quartz sands are materials in high demand from regional manufacturing and construction market sectors. The key issues to end users are product quality and delivered cost. Product quality will result from the quality of the resource itself and the degree of downstream processing required.

Industrial mineral and construction sand markets are highly sensitive to transportation costs. Resources must therefore be located as near as possible to consumer markets and/or have transportation arrangements that permit transportation of the product in an economically viable manner. Given the extent of processing required and the fact that the bulk of excavated material needs to be transported to Sydney (as either raw feed or processed product), the decision has been made to rail all of the crushed sandstone to Sydney for processing and subsequent sales distribution.

The proposed development site is located immediately adjacent to an existing rail loop used by Clarence Colliery for coal transportation. It is sited between two existing industrial developments – Clarence Colliery pit top to the north west and Rocla Quarry to the south. The site is also adjacent to the Blue Mountains National Park to the east. The nearest residences are located in the village of Newnes Junction, a small community adjacent to the railway. It is therefore located away from densely populated areas and is not highly visible from frequently visited vantage points.

The proposal involves transporting the vast majority of the crushed sandstone to Sydney for downstream processing and sales distribution. The decision to transport all of the crushed sandstone to Sydney by rail, will assure far better utilisation of the existing Clarence rail loop and eliminate the need for high truck volumes and impacts on local and regional roads.

4.4 Production and Sales

The Company is planning a staged entry into the market, with a progressive volume increase of mining until the target goal of around 1.4 Mtpa is reached. Capital investment in processing and product beneficiation plant in the Sydney area will be linked to market demand for the individual sand and kaolin products to be produced. Initial investment will be for plant capable of processing crushed sandstone to produce:

- ❒ building material, ceramic clays (white firing clays), and metakaolin (cement pozzalan);
- ❒ construction sand (quartz sand);
- ❒ pea gravels (landscaping);
- ❒ filter sand (quartz sand);
- ❒ silica flour; and
- ❒ glass sand (flint grade).

Sales forecasts of refined products at maximum production of 1.4 Mtpa of friable sandstone, based on market research is shown on **Figure 4.3**.

Plant design will be modular in order to allow additional processing and beneficiation plant to be installed as higher value product quality is proven and markets penetrated / captured. Whilst the project will be ‘construction sand driven’ in its initial stages, it will become increasingly ‘kaolin revenue driven’ once existing reserves are exhausted and kaolin markets are consolidated.

4.4.1 Marketable Products

End products can readily be classified into two major groupings: kaolin products and silica sand products. The silica products can be sub-divided into industrial mineral sands (glass sand, filtration sand etc) and construction sands (concrete sands etc).

The potential success of the Newnes Junction Project lies in the wide diversity of marketable products that can be separated and refined from the friable, chemically weathered sandstone to be extracted at Newnes junction. Considered on a ‘per tonne’ basis, the most valuable component of the sandstone will ultimately be the kaolin.

Although kaolin is one of the most valuable industrial minerals contained in the friable sandstone ore, the deposit is best considered to be a multi commodity deposit wherein each of the refined components contributes to the economic success of the mining project.

One of the keys to the long term commercial viability of the proposed project will the planning, management and attaining of stock balance between the production and sale of the various sand and kaolin products. This is why the production and sale of all products will be to a large extent dictated by sales of construction sand in the initial years of the project. Market analysis and financial modelling demonstrate that the project has the potential to become ‘kaolin revenue driven’ in about its fifth year of operation.

Extraction of the kaolin by wet processing of the crushed sandstone involves several phases of attrition, washing and separation. As a result, the quartz sand particles are imparted with a high degree of purity that enhances their suitability for a whole range of industrial silica products, including glass sand and high purity silica flour.

Testing of the kaolin has proven the suitability of the mineral for use as a principle raw material in the manufacture of refractories and ceramic products. In addition, high gradient magnetic separation and calcination of the kaolin provide strong indications that the calcined kaolin will be able to be marketed as an extender for titanium dioxide and used as an opacifier in paints and paper. The proponent is currently exploring the concept of producing ‘metakaolin’ for use as a concrete additive able to significantly enhance performance characteristics of cement-based mortars, concretes and related products. If successful, the concept presents the company with an exciting possibility to produce and market a new product.

The range of kaolin products listed in **Table 4.1** shows its use for bricks and pavers at the lower end of the value scale through to ceramic and refractory kaolins, metakaolin and paper and mineral fillers at the upper end.

It is envisaged that during the start up phase of production, marketing will focus upon those products with proven markets and/or those that require the minimum amount of processing. As metallurgical test work advances and markets are determined, the higher value products will be produced by bringing on line the more advanced processing techniques required to refine these products.

4.5 Marketable Kaolin Products

Kaolin is a near-white clay, predominantly composed of the mineral kaolinite. For many modern industrial applications kaolin must be extensively refined and processed from its original state to obtain important commercial characteristics. After refining and beneficiation, kaolin ranks as one of the most valuable of the industrial clays.

Kaolin is used in two main areas, these being:

- the heavy clay industry; and
- so called ‘other applications'.

The heavy clay industry makes use of clays that are not beneficiated and may incorporate substantial quantities of fine silica, in this case –10 micron material. So called ‘heavy clays’ are used as a raw material in the manufacture of a range of important building materials such as clay bricks, pavers, roof tiles and earthenware pipes as well as ceramic whiteware and tiles etc.

Whilst some heavy clay values are relatively low, they escalate substantially in the Sydney Metropolitan regions for good quality white firing and ceramic quality clays, such as that will be available from the Newnes Junction resource. Good quality, white firing clays used in the Sydney brick making industry are currently ‘imported’(at considerable transport cost) from locations such as Windellama, south east of Goulburn.

Table 4.1 – Marketable Products

Mineral	Grouping	Product
Kaolin	Building Materials	- Bricks / pavers (cream to white firing)
		- Bricks / pavers non-cream to white firing)

Table 4.1 – Marketable Products

Mineral	Grouping	Product
		- Plaster board - Whiteware, tiles, glazes
	Ceramics / Refractories	- Pottery, insulators - Refractory "grog"
	Cement Pozzolan	- "Metakaolin" (Strength enhancer for concrete)
	Calcined Kaolin	- Paper coaters - Paper fillers (opacifers) - Paint and plastics fillers - Adhesive fillers
Silica	Building and Construction Sand	- Ready mix concrete sand - Concrete tiles, pipes, bricks and pavers - Prefabricated concrete products - Asphalt - Fibre cement - Bricklaying sands - Pipe laying sands
	Specialty and Industrial Sand	- Silica Flour (for fibreglass, rubber, ceramics, abrasives, glaze & paint fillers) - Fine silica sand (for cements, abrasives, chemicals) - Glass sand (flint grade) - Sand blasting media - Filter sands - Oil and gas drilling sand - Bedding sand
	Landscaping and Recreational Product	- Fill - Home hardware / garden - Landscaping / horticultural - Golf bunker sand - Soil blends

Kaolins that are used for so-called 'other applications' are generally of a higher grade and often require beneficiation. These kaolins are used in a wide range of product areas including high quality ceramics, refractories, mineral fillers and paper manufacture. Prices obtained for such kaolin are generally far higher than for heavy clays. Refined / beneficiated kaolin products are used for paper filling and coating as well as in the manufacture of paints, plastics, adhesives and auto exhaust emission catalytic converters. It is also used as an ink pigment; rubber reinforcing agent; raw material for porcelain, dinnerware, and enamels and as a catalyst base for petroleum cracking.

4.5.1 Building Materials

Kaolin of various types is widely used in ceramics and for house bricks and pavers. Kaolin is also used in the manufacture of plasterboard and wallboard.

White firing kaolin is highly sought after in Sydney by manufacturers of house bricks, pavers and roof tiles. The major manufacturers of bricks in Sydney, including Boral, Austral Bricks, PGH / CSR and Norbrick currently import a white firing kaolin clay from the Goulburn-Marulan area, to blend with lighter firing clays and shales to produce a lighter coloured product. Discussions with each of the major manufacturers has confirmed that availability of the Newnes Junction kaolin from a processing plant located in the greater Sydney area will allow the proponent (NKPL) to compete favourably with kaolin currently being trucked in from the Goulburn-Marulan area.

Austral Bricks have recently commissioned a new tile plant in Sydney for the production of outdoor decorative tiles and pavers, which feature an 'alabaster' light cream coloured variety. NKPL anticipates that the product, which is composed of 40% kaolin raw materials, will provide another excellent outlet for the kaolin produced from the friable sandstones.

4.5.2 Ceramics/Refractories

Refractory clays are those that are able to keep their shape and properties at high temperatures. As resistance to heat is the most essential property, the end products must fulfil rigid specifications. PCE (Pyrometric Core Equivalent) is a technical measurement of the property. The Newnes Junction kaolin has a PCE in the range of 30 to 33 confirming its potential as refractory kaolin. In addition, the low alkali and extremely low iron contents of the Newnes Junction clay are favourable for refractory kaolin production. Since the closure of Australia's sole producer of refractory clay (Merrygoen in NSW), Australia imports all of its 10,000 tpa needs.

Kaolin of various types is also widely used in ceramics such as pottery, sanitaryware, insulators, house tiles etc. Discussion with a number of major ceramic producers and/or kaolin suppliers confirms that much of the existing kaolin supply comes from Albury Fields in the south of NSW. Discussions also indicate that the Newnes Junction kaolin should be in a strong competitive position because of its inherent mineral qualities and location.

4.5.3 Cement Pozzolan

High Reactivity Metakaolin is a manufactured mineral admixture made from kaolin clay. It significantly enhances many performance characteristics of cement-based mortars, concretes and related products. When used as a 5-15% replacement for cement, metakaolin can result in increased strength, reduced permeability and greater durability. Metakaolin has been shown to outperform the more traditional concrete admixtures such as silica fume and fly ash from coal fuelled power stations. Metakaolin is currently not produced in Australia.

Australia produces 10,000 tpa of silica fume as a byproduct of silicon metal production. Forty per cent (40%) of this is required for the production of refractory materials while the remaining 6,000 tonnes is used as a cement pozzolan. Expressions of interest have already been shown by major Australian cement producers to further evaluate the advantages of using High Reactivity Metakaolin (HRM) in their products. Average price per tonne of Australian (Simcoa, WA) silica fume is $500/tonne bulker bagged. Imported HRM from the UK is costed at $850/tonne.

The prospect of becoming a long term supplier of metakaolin in Sydney at a competitive price is one of NKPL's long term aims and part of its marketing strategy to increase the base selling price of its kaolin products. NKPL intends to fully investigate and pursue this market potential via extensive laboratory research and ongoing discussions with all major cement manufacturers.

4.5.4 Calcined Kaolin in the Paper Industry

Calcining involves upgrading the natural hydrous kaolin by heating to high temperatures. Calcining removes the water of hydration of the basic particle, changes the natural particle shape and makes the kaolin whiter and brighter.

Calcined kaolin is well established in the industry as the most significant high bulking extender pigment for the paper industry. It has opacifying properties second only to titanium dioxide.

Calcined kaolin is the most widely used extender of titanium dioxide in paper applications and is the least expensive and therefore the predominant mineral used. In application, the kaolin is used as a coating in paper manufacture to improve opacity and brightness and to control absorption of inks into the paper during the printing process.

Preliminary testing of the Newnes kaolin by the Department of Mineral Resources has shown that although the calcined kaolin (following magnetic beneficiation) meets the brightness specification it only does so at calcination temperatures in excess of 1050^0C (Kmentoni, 1984). The economic viability of this project is not dependant on the successful production of calcined kaolin. Further technical evaluation will be carried out once the project commences.

4.5.5 Calcined Kaolin in the Paint Industry

Mineral products are added to compounds to improve certain performance characteristics. The main reason for using them is to reduce the cost of the end product. The inclusion of a filler such as kaolin, generally costs a fraction of other materials used in paints and plastics such as expensive pigments, polymeric resins, pulps or rubbers.

Kaolin is used in paint, providing high covering power as well as desirable flow and suspension properties, viscosity and corrosion and weathering resistance. It is used in the increasingly popular water-based paints where coarse grades provide a matt finish and finer grades a gloss finish.

Plastic resins generally have some kind of filler added to them and kaolin is a suitable material for such use due to its dispersibility, low abrasive characteristics and flow properties. It is also widely used as a filler in adhesives and sealants.

4.6 Marketable Sand Products

The great bulk of materials produced during the initial processing of the friable sandstone will be sub rounded, fully graded, quartz sands. Dependant on impurities present, the degree of processing undertaken, and final product specifications, these sands will be suitable for a range of uses ranging from high grade industrial sands to premium quality construction sands, and landscaping sands and 'pea' gravels. Good quality industrial sands will be available at a relatively early stage of product development.

4.6.1 Construction Sands

Construction sands incorporate an extensive range of coarse, medium and fine graded products as well as blended and fully graded sands. In general, these sands require less processing than specialty and industrial sands and will dominate the Company's sand sales in the early years of operation. Premium quality construction sands such as those derived from the Newnes Junction resource are used in substantial volumes for the manufacture of:

- ***Ready Mixed Concrete*** – Supply of sand to this market segment is generally subject to rigorous laboratory testing to ensure it meets stringent quality assurance requirements. The sand needs to be strong, durable, sound, chemically inert, suitably shaped, neutrally coloured, free of deleterious materials and fully graded.

- ***Concrete Products*** – Sand specifications are often similar to those for ready mixed concrete sands in terms of mechanical properties and chemical inertness. Differences in specifications principally relate to sand gradings, which differ according to individual product requirements.

- ***Fibre Cement*** – Manufacturer specifications call for clean fine quartz sand (ex Kurnell or equivalent) which is subsequently ground to finer grades prior to manufacture of fibro, Hardiflex and similar products.

Other markets for Newnes Junction quality sand include asphalt manufacture, general building and plumbing applications, landscaping applications and bagged 'hardware' sands. Lesser value markets include sale of the product as bedding and/or filling sand. The great bulk of the sand will however be sold at the 'top end' of the construction sand market, that is, to the manufacturers of ready mixed concrete and concrete products. The latter include pre stressed concrete panels and beams, concrete culverts, sleepers, masonry bricks, blocks, pavers, tiles, pipes, and so on.

4.6.2 Specialty and Industrial Sands

Many industrial mineral products use industrial sands as raw materials. These include:

- ❒ ***Silica Flour*** – Silica flour is used by companies that manufacture fiber-reinforced cement products, ceramic tiles and sanitaryware (eg. toilets).
- ❒ ***Fine Silica Sand*** – Fine Silica Sand has a wide range of uses including abrasive cleaners, acid proof cements, adhesives, carpet backing, epoxy concrete, foundries, grouting compounds, miscellaneous chemicals, paints, paper impregnation, polyester resins, polymers, putties, toothpastes and cleaners, glazes and frits, mould washes, paints, plastics, refractories, rubber products and sealants. Letters of interest have already been received for the export of this product to Asia and US markets.
- ❒ ***Glass Sand*** –Glass sand is the major component of glass. Two sands are commonly used in glass melting, a white low iron oxide sand for flint glass and a higher iron oxide amber sand for coloured glass and most flat (window) glass. Although amber sand has a higher oxide content, both products are required to have specified and consistent chemical composition and particle size distribution. It is technically feasible to produce both flint and amber glass sands from the friable sandstones at Newnes Junction.
- ❒ ***Filter and Drainage Sand*** – These sands are generally coarser and more single sized sands to enhance porosity. Industrial filtration media consists of washed and graded quartzose gravel and sand for the removal of particulate matter and bacteria from municipal and industrial water supply systems. These sands are currently understood to be sourced from Brisbane.

4.6.3 Landscaping and Recreational Sands

Sand is used in the upkeep of sporting facilities such as golf courses, cricket grounds, racecourses and football grounds. It is anticipated that the Newnes Junction deposit will be able to supply a range of quality sands to individual specifications.

4.7 Kaolin and Sand Markets

The company is planning a staged entry into sand and kaolin markets, with progressive volumes and quality of product being produced until the target goal of around 119,000 tpa of kaolin and 1.281 Mtpa of sand is reached.

Specialist consultants were employed to undertake research into the potential markets for the various products capable of being produced with the ore mined from Newnes Junction.

4.8 Overall Market Analysis

4.8.1 Kaolin Markets

The Department of Mineral Resources Laboratories has carried out investigations (Kmetoni, 1984) on the kaolin fraction of the material to be mined (obtained from adjacent sites). Analyses conducted included chemical tests, mineralogical analyses, particle size, firing characteristics and refractoriness. The analysis concluded that the kaolin clay was at least suitable for whiteware ceramics and that with beneficiation would grade up to more expensive high quality micronised kaolin products used for industrial purposes such as high brightness fillers.

Worldwide, around 40 million tonnes of kaolin is produced annually, of which 24 million tonnes is consumed by the paper industry. Kaolin is mined and processed in many countries and is one of the industrial minerals of sufficient value to be widely exported throughout the industrialized world. Currently, major exporting nations include the United States, England, Brazil and Indonesia. Key importing nations include China.

It appears that there are ample market opportunities for Newnes Junction Kaolin products in NSW and around the world, with numerous export markets existing in Asia and New Zealand, depending on the consistency of final products produced.

The market supply and demand for within industries using kaolin products is described in the following sections.

House Bricks and Pavers

Kaolin of various types is widely used in ceramics and these markets offer some reasonable scope for Newnes Junction Kaolin products. Both the white kaolin from the "premium" ore and the off-white kaolin from the "standard" ore are suitable for these products.

Plaster / Wallboard

This sector represents a possibly very good target market for Newnes clay, as there are several very large users including La Farge, CSR and James Hardies, all of which take thousands of tonnes of reasonably high priced clay and take delivery in bulk tankers. It is suggested if a clay suitable to these companies can be produced it would be a very good base load of higher value clays. The feed would also be useful as Metakaolin and potentially grog products of very attractive value, without the need to transport from the Albury district.

Ceramics / Refractories

The availability of high grade and very high grade refractory clays at competitive costs is one of the long range problems faced by the refractories industry. Molochite®, the tradename for the calcined refractory grog, is produced by Imerys in the United Kingdom and also in China. The Newnes Junction refractory kaolin products could replace imports from both these countries. Consequently, there may be markets for materials produced by NLPL.

Metakaolin

The use of kaolin materials as a pozollanic admixture in the manufacture of concrete may generate significant markets for Newnes products, replacing the less effective traditional pozollans of fly ash and silica fume.

4.8.2 Sand Markets

Principle markets for sands include:

❒ ***construction sand***
  - ready mixed concrete
  - concrete tiles
  - concrete pipes
  - concrete bricks & pavers
  - prefabricated concrete products
  - other concrete products
  - fibre cement
  - asphalt paving
  - mortar (‘brickies sand’)
  - bedding
  - fill
  - plaster, render and grout
  - filter and drainage
  - sport facilities (tennis courts etc)
  - landscaping, horticulture and nursery propagation
  - general building and construction (via resellers, hardware outlets, direct sales etc).

❒ ***industrial sand***
  - glass
  - ceramics
  - abrasives
  - cleaners
  - foundries.

❒ ***soil blends***
  - containing up to 50% natural sands but sold ex-pit as soils.

Construction Sand

Demand for construction sands from Sydney Metropolitan area markets averaged 5.8 mtpa during the five year period 1995/96 to 1999/00, peaking at 6.73 million tonnes in 1999 / 2000. It is estimated that more than 57% of this was supplied to just two market segments – the manufacturers of ready mixed concrete (49.4%) and concrete products (7.7%). Based on historical data, total demand is projected to increase at an average 1% per annum to reach 6.85 mtpa during the five year period leading up to 2019/20.

The technical advantage built in to the washed friable sandstone produced from Newnes Junction is that it is a fully graded sand and does not require any blending of either a coarse component or a fine component sand for usage in ready mix concrete. Indicative grading curves for washed construction sand supplying the Greater Sydney Area compiled by Pienmunne and Whitehouse (2001), refer **Figure 4.4**, clearly highlights the close conformity of the Newnes Junction grading curve with the grading envelope most widely accepted by industry (Don Reed and Associates, 2000).

The bulk of sand consumed by ready mixed concrete manufacturers comprised coarse river sand blended with fine dune sand, sourced from Penrith Lakes and Kurnell respectively.

In the 1999/2000 financial year, more than 19% of the natural sand consumed by Sydney's construction industry had to be imported from outside the region. Thus, the industry had to import more than 1 Mt of 'natural' sands, despite the substantial growth in the availability of alternatives, including so called manufactured sands (hard rock crusher dust), recycled concrete and brick sands, slag and crushed sandstone.

Based on current projections and assumptions, Sydney Metropolitan area markets will experience shortages of construction sands of approximately:

- 38% (2.4 mtpa) during the period 2005/06 to 2009/10;
- 74% (4.9 mtpa) during the period 2010/11 to 2014/15; and
- 86% (5.95 mtpa) during the period 2015/16 to 2019/20.

The main cause of the shortages will be the cessation of sand extraction at Kurnell in about 2005/06 and at Penrith Lakes in about 2010/12. The exhaustion of quarriable reserves at these two locations will decrease Sydney production of construction sands by about 1 mtpa, and 2.8 mtpa respectively.

If reserves of both coarse and fine sand are to be exhausted during the period 2005/06 to 2010/11 within the Sydney metropolitan region, then it can be readily argued that all future studies should be concentrated on identifying the best possible sources of naturally occurring, fully graded sands in proximity to Sydney markets.

The DMR and others, have identified the Newnes Plateau and Penrose/Wingello area in the Southern Highlands as the two principle, long term sources of fully graded, premium quality construction sands for supply into Sydney Metropolitan markets. The full strategic value of these resources will be realised once reserves of coarse and fine sand at Penrith and fine sand at Kurnell are exhausted, in 5 to 10 years.

DMR reports authored by Spackman (1992) and Lishmund, Oakes & Patterson (1995) refer to Pecover's 1986 report that concludes (inter alia):

> *'The Sydney region currently faces a shortage of fine, medium and coarse graded construction sands. The shortage of sand is expected to become critical by the*

> *end of this century as existing sources are depleted…. The high quality and immense size of the sand resources of the Newnes Plateau could lead to development of the area as the major source of supply to the Sydney region into the next century.'*

The site controlled and geologically explored by Newnes Kaolin Pty Ltd (NKPL) is understood to contain at least 23.7 million tonnes within the proposed Mining Lease, of fully graded premium quality sand product. From the considerable data base of technical information available, it can be confidently forecast that fully graded sand product will be at least the equivalent of any existing blended sand product, in terms of sand quality.

Long term sales opportunities for the sale of NKPL sand can be forecast in excess of 1 Mtpa as a part replacement for forecast shortages of 2.4 Mtpa after 2005/06, to 5.95 Mtpa by 2019/20. Newnes Junction sand will be in demand on the basis of its long term availability, quality (particularly grading) and delivered price into Sydney markets.

The commercial viability of the project hinges on a number of factors unique to the NKPL site. These include:

- massive, long term reserves located in relative proximity to Sydney markets;
- the pending exhaustion of extractable sand resources in the Sydney metropolitan area;
- the high quality of the sand, particularly in relation to grading and shape;
- costs economies attached to high volume extraction, processing and sales;
- long term, rail transport economies;
- the optimisation of product yields from sand extracted that will result from the processing and sale of industrial sands and matrix clays.

The combined effect of these and other environmental and operational factors, should be to ensure the long term viability of proposed extraction of friable sandstone at the NKPL site.

Industrial Sands

Silica Flour Production

Australia produced almost 3 Mt of silica flour in 2000 versus 1.928 Mt in 1993, with export destinations including Japan, South Korea, Papua New Guinea, the Philippines, Taiwan, and the U.S. Queensland produced 2.829 Mt of silica in 1994/95 versus 2.494 Mt in 1993/94; Western Australia produced 742,000 t of silica flour from more than 6 operations in 1995/96; New South Wales produced 611,000 t of silica in 1993/94; and South Australia produced about 133,000 t in 1995/96.

Current production of ground silica flour in Australia is 40 to 43,000 tpa, even though installed production capacity is at least 168,000 tpa. This production excludes the very large tonnages of silica that are ground captively by companies that manufacture fiber-reinforced cement products, ceramic tile bodies (eg Johnson Tiles), and sanitaryware bodies (eg Caroma). Reportedly, such silica is being wet ground and delivered directly into the manufacturing process. When the in-house supply is interrupted occasionally, due to equipment repairs for example, these companies purchase silica flour in large volumes, on very short notice, and at prices considerably in excess of their own wet milling costs.

Of the total tonnage of silica flour sold in Australia, 45% is delivered in bulk tanker trucks (with ACI Fibreglass being the largest customer), 15% is delivered in 1 tonne bulk bags, and 30% is delivered in 25kg paper bags. The use of 40kg bags has been outlawed by labour unions. Exports are mostly made in bulk bags.

Glass Sand

Apart from a few "cottage industry" operations the NSW glass industry is currently understood to comprise seven plants. In terms of glass tonnage, the most significant of these plants is ACI Glass Packaging Australia (ACI-GPA) at Penrith, and Bradford Insulation at Ingleburn. Together the two plants account for in excess of 80% of the total glass sand demand.

Currently the demand for glass sand is met by two groups; PB White Minerals Pty Ltd (PBWM) and Unimin Australia (formerly ACI) from resources in the Port Stephens area.

Two sands are commonly used in glass making, a white low iron oxide sand for flint glass and a higher iron oxide amber sand for coloured glass and flat glass. A flint grade glass sand is normally required to have an iron oxide content of $\leq 0.03\%$ whilst an amber glass may call for an Fe_2O_3 content of 0.15%.

Stitt and Morris (1973) and Stitt (1974) have demonstrated that it is possible to produce a flint grade glass sand from the Kable Sands (Pioneer) friable sandstone resource on the Newnes Plateau by a process involving grinding, sizing, high pulp density attritioning and froth flotation.

However, given the low iron content (averaging 0.028 % from washed drillhole samples) of the premium grade friable sandstone at Newnes Junction, NKPL proposes to selectively mine and stockpile the resource into premium and standard grades of sand.

The processing plant design by Roger Smith and Associates (1999, 2001) incorporates a single process, dual strand system for co-processing both grades of sand.

Grading of the washed premium sand would be carried out by a series of parallel hydrocyclones followed by drying and storage in bins.

Chemical analyses of the premium grade drillhole samples from Newnes Junction (EL 4192) shows conformity with the industry requirements for the flint grade glass sand, and highlight the economic and environmental advantages of bypassing the beneficiating process outlined by Stitt (1974).

Long term production of silica sand for flint glass manufacture in the Sydney region may ultimately depend on the availability of friable sandstone deposits. The Newnes Junction resource is located adjacent to rail transport for delivery to a processing plant in the Greater Sydney Area. The proven chemistry of the premium grade sand makes the Newnes Junction resource an excellent candidate for future supplies of flint grade glass sand for Sydney markets.

4.9 Summary of Project Justification

A large part of the justification for developing the Newnes Junction Kaolin resource relates to the regional significance of the resource and growing regional demand for the products. These factors in turn relate to the:

- size and quality of the resource;
- proximity to the Sydney and regional markets;
- quality and range of specified kaolin and sand products to be produced;
- substantial markets available for high quality kaolin products;
- growing regional demand for blended and classified sand products; and
- diminishing supply of quality sand product within regional markets, particularly near Sydney.

The project represents a significant advancement in resource utilisation, product beneficiation and value adding when compared to conventional friable sandstone quarries supplying product into Sydney markets. The project is considered further justified by resource optimisation and impact minimisation, the latter primarily resulting from decisions taken in relation to rail transport and off-site processing.

4.10 Alternatives Considered

There is a range of development alternatives that can be considered. Project planning in its current form has been developed over a number of years and has evolved after detailed evaluation of a number of significant variations. Initial planning commenced prior to the granting of EL 4192. More detailed investigations commenced following the results of the initial exploration phase which proved the value of the resource.

Over recent years there has been a range of detailed planning and investigations including:

- ‘mine’ planning;
- engineering design;
- process design;
- market analysis and detailed feasibility studies;
- environmental investigations.

It is believed that the resultant proposal provides an optimum balance between resource optimisation, operational and commercial requirements, and environmental management.

Key decisions made which formulated the current proposal include the transport of all raw material to a processing site in the Greater Sydney Region, location of the operation adjacent to a rail loop with easy loading facilities, providing a buffer between the operation and the adjoining Blue Mountains National Park, the development of a unique terraced landform allowing early rehabilitation, and the commencement of extraction at the furthest point away from residences in Newnes Junction.

The project has also incorporated a range of mitigation measures covering air, water and noise emissions as a result of the environmental investigations. These mitigation measures have been incorporated into the design of the project as detailed in the EIS. The following is a summary of the principal alternatives considered in relation to the proposed development.

4.10.1 Alternative Development Sites on the Newnes Plateau

The Newnes Plateau has been identified by both the Department of Mineral Resources and the then Department of Planning as containing regionally significant sand resources. The report produced by the Department of Planning in 1990, entitled "Newnes Plateau, Management Strategy for Winning of Sand", identified a number of constraints, planning provisions and development opportunities. The main constraints included the:

- sensitive nature of the catchment and environmental systems in adjacent land;
- surface and groundwater implications;
- impacts on the six dwellings in the village of Newnes Junction;
- constraints on road transport;
- tourism issues; and,
- interaction with other developments including coal mining, public infrastructure and forestry activities.

Given the particular nature of this proposal and the decision to transport all raw feed to Sydney for processing, the requirement to be located near rail loading facilities becomes paramount. It would not be feasible to transport up to 1.4 million tpa to Sydney by road. Indeed, the Plan of Management for extraction within the Newnes Plateau indicates that it may be a condition of any future consent that the material be moved to Sydney by rail rather than road. Also, the capital cost of developing new rail infrastructure away from the main Western Rail Line, particularly through the Newnes Plateau area is not considered feasible.

Although there are other sand resources located on the Newnes Plateau, the quality varies and the knowledge of the mineralogy of the clay content is not proven. Iron content is a limiting factor as is the type of clays present within the sand. The exploration and extensive testing of the resource within EL 4192 has demonstrated that the clay content is pure kaolin and can be successfully separated, which together with the resultant high quality sand component, creates an economically feasible project.

Based on a study of the quality of kaolin at three sites on the plateau, EL 4192 should be capable of yielding close to the highest quality kaolin of the area (Stitt & Associates, 2001). Stitt & Associates (2001) demonstrated that EL4192 is ideally situated on the eastern edge of the Newnes Plateau from the point of kaolin quality. A comparison of the data from the Rocla pit (on the south eastern corner of EL4192) with the two other operational sand pits on the Newnes Plateau shows that following:

- the average Fe_2O_3 content decreases from north to south (3.67% to 1.58%);
- kaolin brightness improves significantly from north to south.

Both these parameters have a major influence on the marketability of the refined kaolin products.

Extensive drilling within EL4192 has clearly shown that the development of ironstone bands over the area proposed for mining is negligible. This is in sharp contrast to the thick ironstone bands encountered in drill holes over the Newnes Plateau (Pecover, 1986).

The Plan of Management for extraction within the Newnes Plateau also identifies that extraction within the Wollangambe River catchment would be subject to significant constraints, in particular, strict controls that would apply to runoff. By not processing the material on site, the use of process water is significantly reduced and water management on site is reduced to the catchment and control of disturbed area runoff. Water inflows within the pit will be used for dust suppression only and will not need to be stored for processing. This simplifies the water management and pollution control systems for the proposed open pit development. .

It is considered that the location of the proposed development site provides the best balance between resource quality, transport requirements and control of environmental impacts, for the project.

4.10.2 Open Pit Design and Planning

Plans for the staged development of the proposed open pit development have evolved over time in response to assessment of individual environmental impacts. Such changes have at all times been assessed and finalised with regard to resource optimisation and best (industry) practice requirements. The pit limits are constrained by the need to provide a buffer between the operation and the National Park, the location of the nearest residences and the rail loop, as well as maintaining of an access way between the National Park and residences.

The pit stages have been developed to ensure that noise and dust impacts on Newnes Junction are minimised, particularly in the early years so that future noise bunding and shielding can be developed for later stages. The pit development has also been staged around the location of drainage lines which cross the site. This will minimise water inflow across disturbed pit areas whilst still allowing for later clean water diversion works.

4.10.3 No Development Option

The no development option involves not extracting the resource. This option would effectively sterilise a resource of 'state significance' whose development will provide an operationally, commercially and environmentally viable solution to construction sand shortages projected from Sydney Metropolitan area markets from approximately 2005 / 2006. The extraction and subsequent sale of the kaolin and industrial sand products will also address regional shortages of essential industrial mineral commodities, whilst at the same time assuring the commercial viability of the project.

The resource and its location are geologically and geographically unique. Principle constraints to the development of sand extraction and processing operations are costs and economic viability. Despite the fact that industrial and construction sands are essential commodities, their value is often relatively low. This particular resource has specific characteristics that make it extremely valuable. The in situ material is effectively construction sand, however, the matrix clay content is dominantly kaolin (rather than a mixture of clays commonly present in other sand resources) and the quartz grains are of high and relatively uncontaminated quality. The separation of the kaolin yields high quality silica sand that can be used not only the construction industry but also for industrial silica sand applications.

Not to develop this project would remove the opportunity to exploit the only known large scale kaolin/sand deposit located immediately adjacent to an existing rail infrastructure. As a consequence, any other large scale kaolin/sand deposit would need to rely on road transport.

The mine plan was chosen on the basis of its limited environmental impact and ability to maximise kaolin yield.

4.10.4 Equipment Alternatives

There is a range of equipment alternatives available, some of which may still be used in the future. The impact assessment has been based on dozer ripping, front-end loaders feeding in pit haul trucks leading to the crushing, screening and stockpile area. The mobile plant investigated is typical for this type of open cut extraction, however, it should be noted that this work is likely to be undertaken by contractor and the equipment fleet may alter.

Alternatives considered could include scrapers that would replace the dozers and haul trucks or an excavator that would replace the front-end loader and dozers. Any variation to the equipment used in the operation would need to be assessed for noise output to ensure that the modelling undertaken as part of this EIS remains valid.

4.10.5 Preferred Option

The plan presented within this EIS represents the preferred mine plan. The plan provides a balance between the proponent's objectives, market expectations and environmental constraints and opportunities.

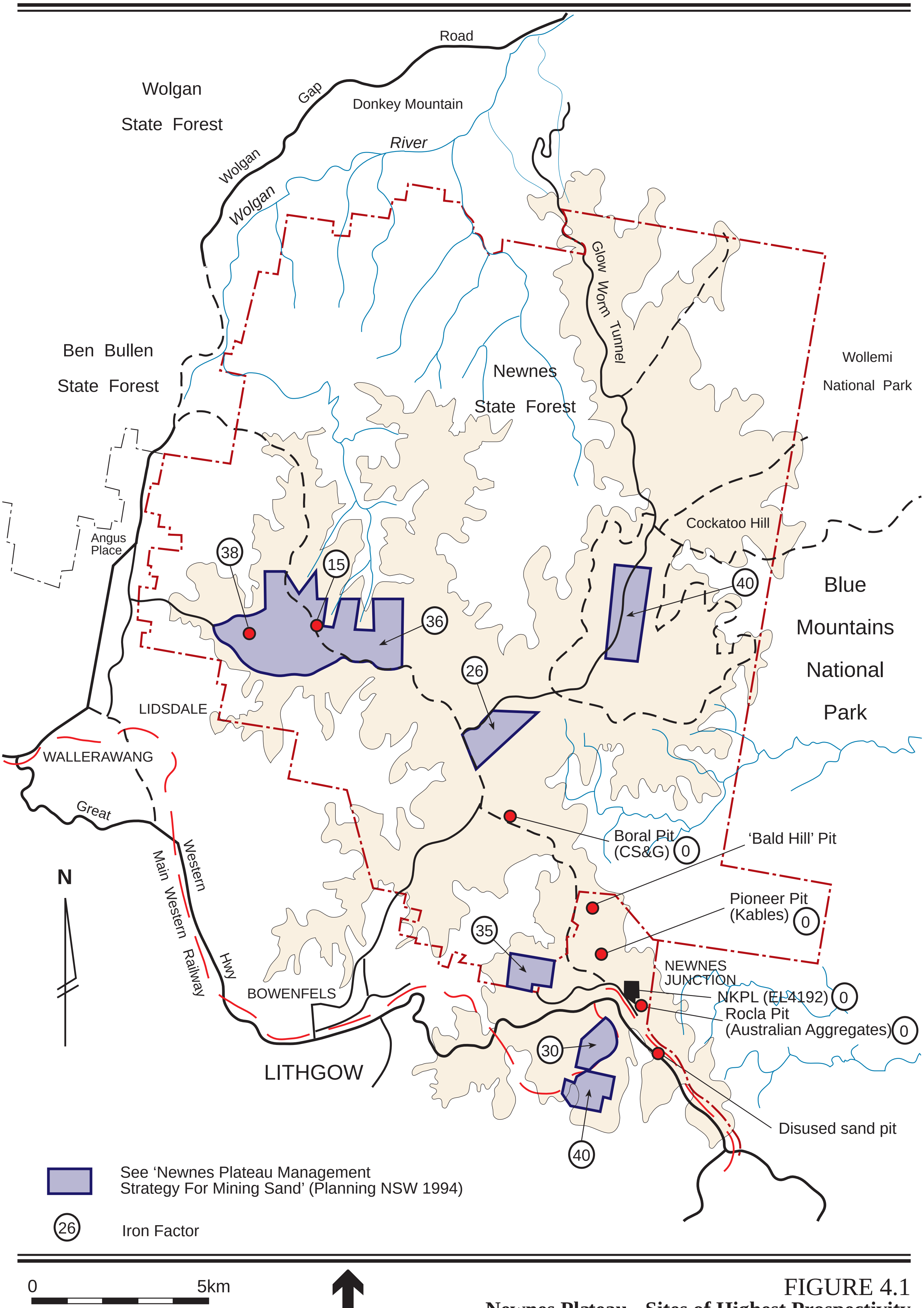
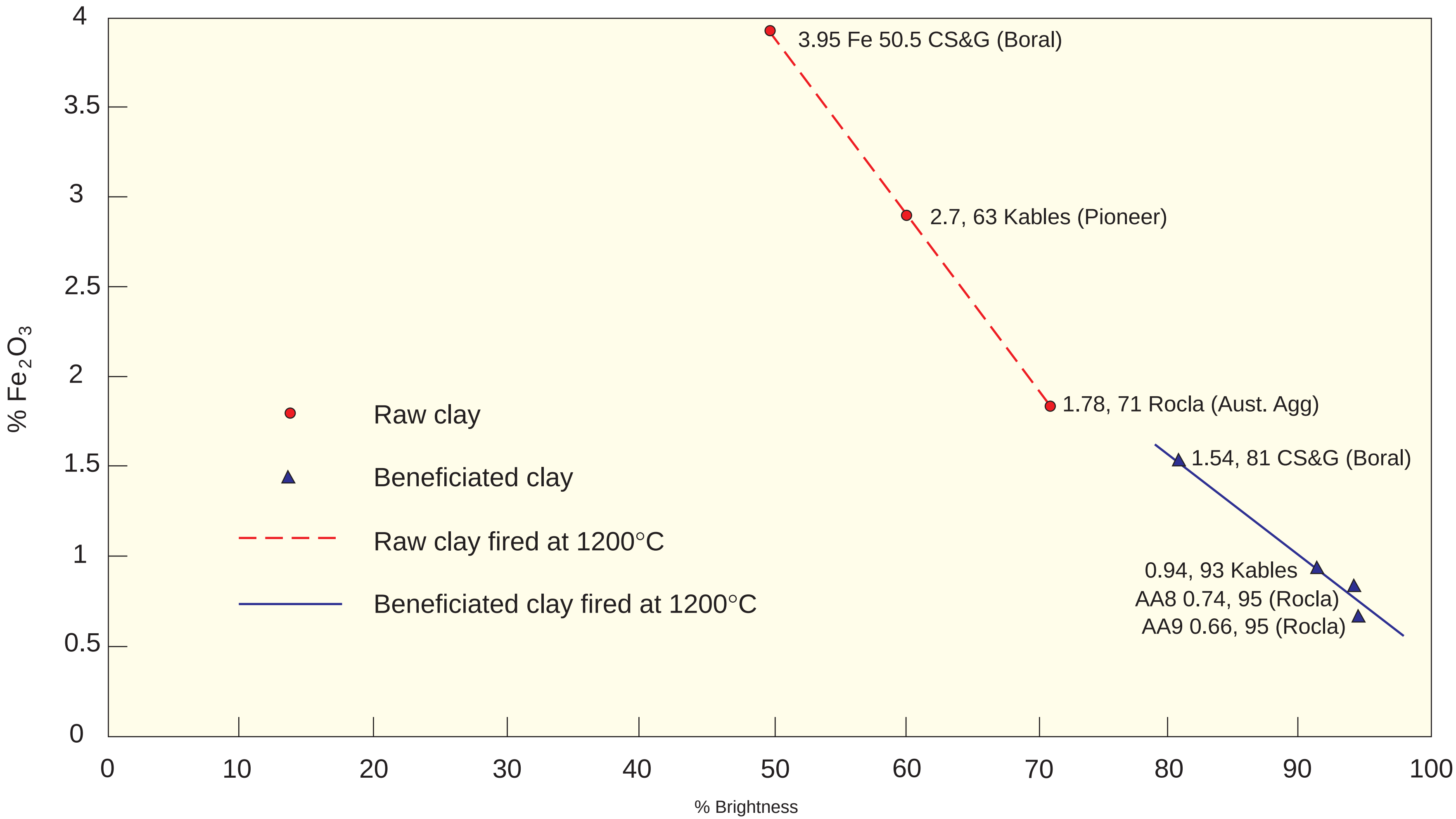


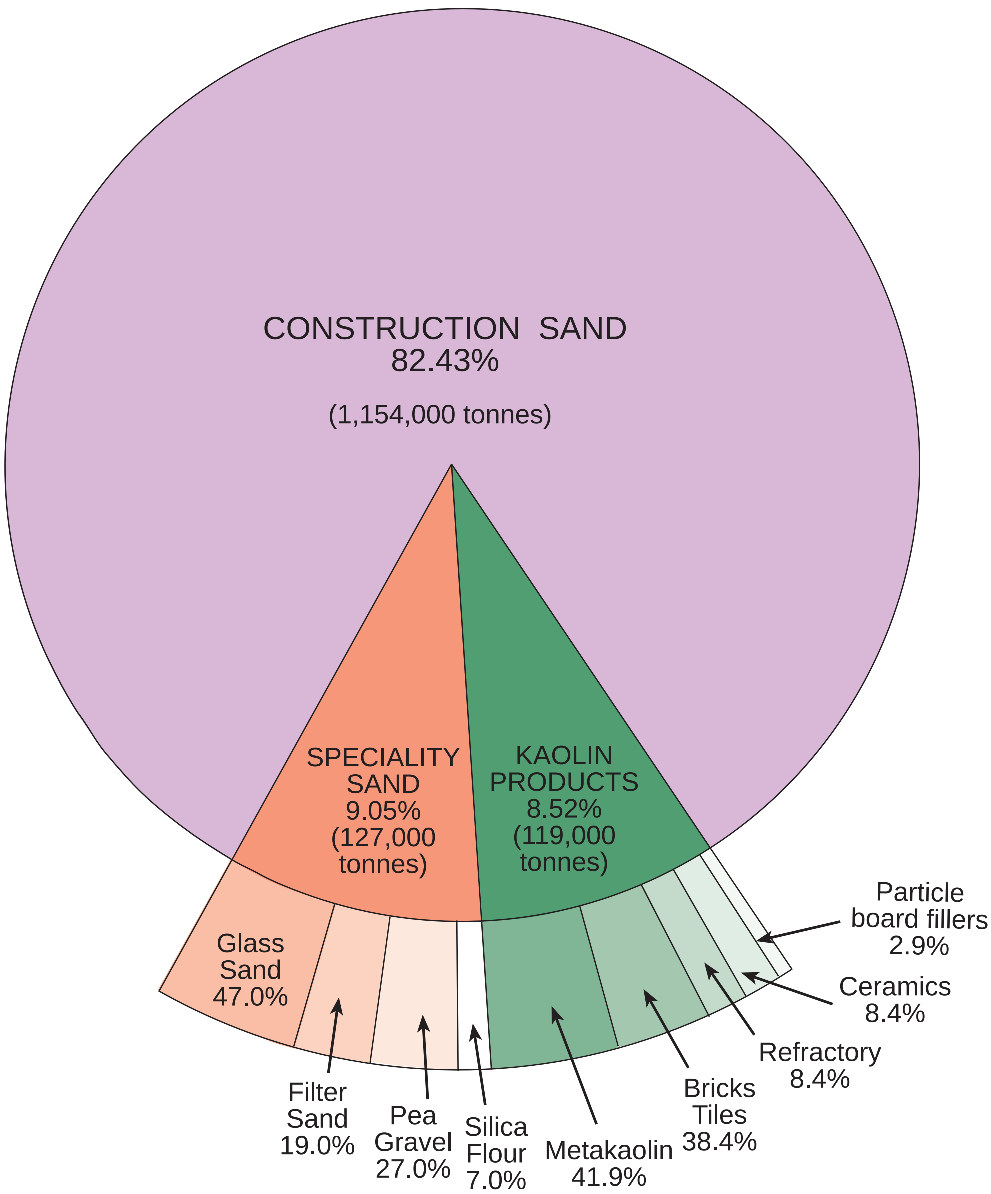
FIGURE 4.1

Newnes Plateau - Sites of Highest Prospectivity For Friable Sandstone (Construction Sand)



Plot of Average % Fe_2O_3 Against Average % Brightness for Three Newnes Plateau Pits - Both Raw and Beneficiated Kaolin, Calcined at 1200°C.

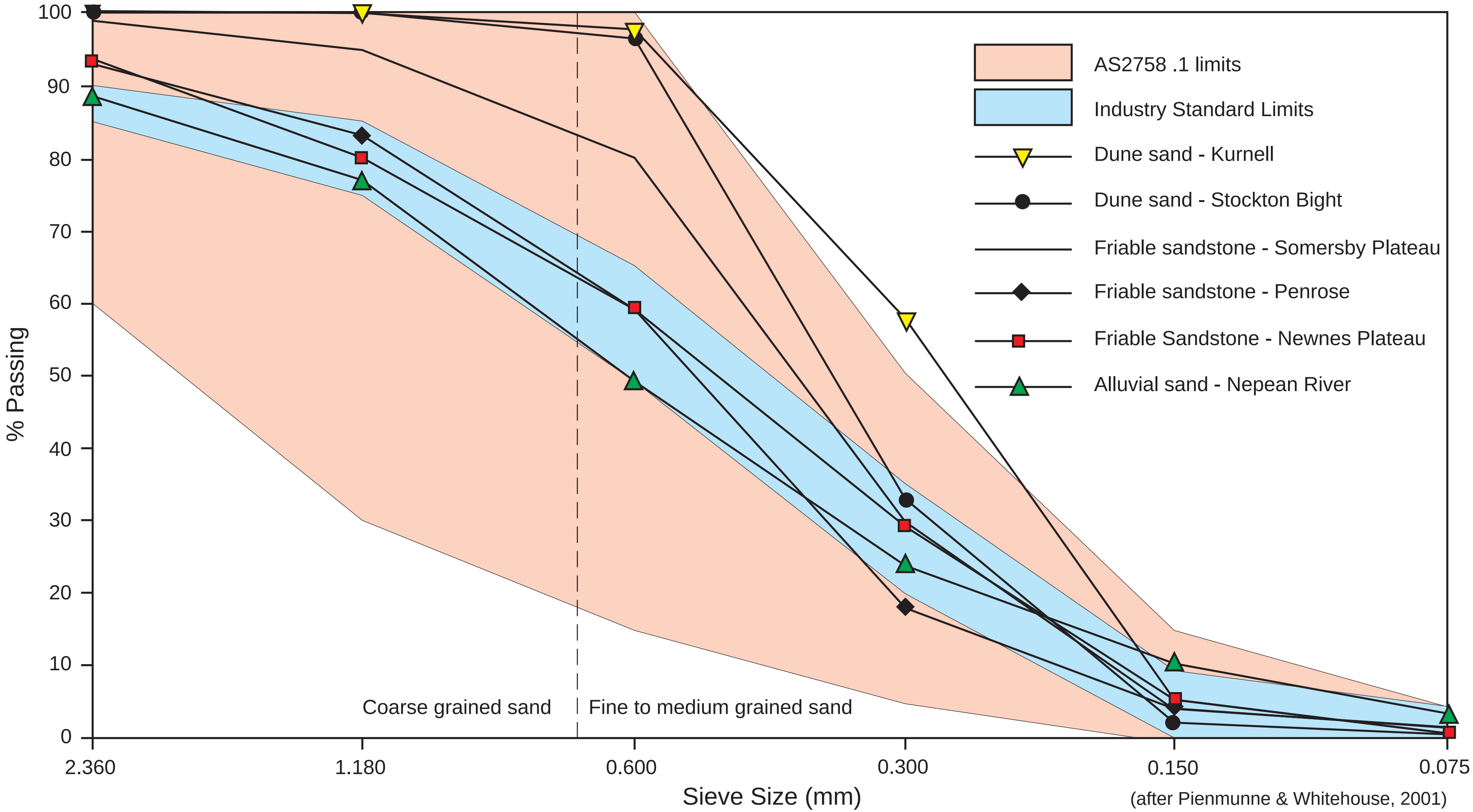
FIGURE 4.2
Average % Brightness Raw and Beneficiated Kaolin



Sales Forecast of Refined Products at Maximum Production of 1.4 Mtpa of Friable Sandstone.

FIGURE 4.3

Sales Forecast of Refined Products



INDICATIVE GRADING CURVES FOR WASHED CONSTRUCTION SAND SUPPLYING GREATER SYDNEY AREA

FIGURE 4.4

Grading Curves for Washed Construction Sand