The Story of
CEMENT

BLUE CIRCLE SOUTHERN

Cements built to perform

Cement the strength and versatility of a proven past - and a dynamic future

Throughout the ages - from prehistoric time till today - the search for increasingly more sophisticated building solutions goes on. Versatility and durability are our primary goals.

The Egyptian Pyramids

The widespread use of stone - from caves to catacombs to cathedrals - gave an inconsistent strength and not much flexibility.

Egyptian Pharaohs, some 4500 years ago, carved giant blocks of stone from the earth. They bound them with mortars made by burning gypsum; producing a substance similar to what we know as Plaster of Paris.

A Russian Cathedral

Early Greeks made crude mortars from burnt lime. Ancient Romans discovered mortars would set in water by adding volcanic ash to the burnt lime mix.

Modern scientific discoveries reveal those early civilisations had a sophisticated knowledge of mortars and their applications. Yet somehow this knowledge was lost. And so, the search went on:

The York Park Estate

the search for 'versatile' stone - stone with the strength to withstand and protect against the elements, yet with the adaptability to build and shape it how, and where, it's wanted.

Not until the nineteenth century did a scientific understanding of cement, as we know it, emerge. In 1824 in England, Joseph Aspdin patented Portland cement. He named his product for its resemblance to stone quarried at Portland, England - stone prized for durability and solidity. Regarded as the 'father of the cement industry' Aspdin's invention heralded a new era in building.

Modern designers and builders now have a material readily available to match their talent and imagination. Designs are no longer dictated by the naturally occurring shape of the stone, or by weaknesses of natural flaws and faults.

Long spans and curves, intricate shapes, appealing colours and finishes are a building reality. Versatile, durable cements are also one of the most inexpensive building materials available.

Those features earned high respect in the past. And still today, concrete remains a most versatile and strong building solution.

Versatility, strength and durability continue to develop at Blue Circle Southern Cement, making concrete and mortar, not only the building solution of the past and the present... but also for the future.

Yesterda

Today

Cement manufacturing is a complex chemical process requiring precise control. The Blue Circle Southern team commands a high level of scientific expertise to harness the resources of leading edge technology.

Science and skill combine to continually produce improved strength, durability and flexibility in new and different cements. Our Blue Circle Southern people determine what specific cement characteristics best suit a particular task then design cements capable of achieving those special performance requirements. Perhaps the cement needs to be particularly resistant to salt water, or to gain initial strength quickly. It may end up applied with a trowel or pumped under high pressure.

At Blue Circle Southern, cement quality is defined by the measure of our products' performance in service. The Company's strict quality control measures emanate from a quality assurance programme designed to ensure these products perform in a consistent and predictable way. Quality control is not simply testing the finished product. It is an essential component of each stage in the manufacturing process.

Mandatory procedures in place at each of Blue Circle Southern's NATA-accredited laboratories provide checks at all stages of the process.

Blue Circle Southern laboratories are equipped with the most up-to-date instruments and technology. Scanning Electron Microscopy, ambient and high temperature X-ray diffractometry, auto x-ray fluorescence and calorimetry provide chemical analysis and measurement of such properties as mineralogical and morphological composition and heat of hydration.

Fineness, compressive strength of mortars and setting times of cement pastes are all tested to rigorous standards. Other cement characteristics determined within Blue Circle Southern laboratories include drying shrinkage, sulphate resistance, chloride ion penetration and particle size distribution. All Blue Circle Southern cements comply fully with Australian Standard AS 3972-1991.

BCSC calcite mine at Marulan

Quality control, innovation and an ongoing programme for continual improvement has taken Blue Circle Southern Cement to the forefront of the Australian cement industry and won recognition as an efficient producer by world standards.

BCSC Kiln at Berrima

Blue Circle Southern also markets its technology and expertise overseas, having been selected to train cement plant operators in the Fujian Province of China.

Blue Circle Southern was a major contributor to the design and introduction of the innovative B-Double vehicle in New South Wales.

BCSC Fleet of Trucks

Blue Circle Southern Cement operations are located at Berrima, Kooragang and Maldon in NSW, and at Waurn Ponds in Victoria. Blue Circle Southern operates large open cut mines at Marulan, Waurn Ponds and Portland to supply high grade calcite to the cement works. The marulan plant also produces lime product.

Today's Blue Circle Southern: Cements built to perform

The natural raw materials for cement manufacture

CALCITE

The physical properties of raw materials are also addressed during the selection process.

Grain size and hardness are important. Hard and coarse materials such as silica are difficult to grind. Coarse residues in the prepared raw kiln feed can lead to incomplete combination in the kiln resulting in an unsatisfactory product. Very hard rock types cause extra wear on mobile plant, crushers and mills, increasing cost of manufacture.

Portland cement is made from accurately controlled proportions of materials containing calcium, silica, alumina and iron.

SHALE

Calcium is found in lime-bearing materials (known as calcareous materials) such as calcite, marble, chalk, coral and shell.

Silica, alumina and iron are generally present in clay, shale and sand (argillaceous materials). Alumina is also found in bauxite and iron oxide in iron ore.

These raw materials are naturally occurring, and hence, their chemical composition may vary greatly. Great care is taken in the selection of these raw materials to produce cements possessing specific characteristics.

SAND

In Australia, the principal source of calcium is from calcite (a member of the limestone family). The largest open cut mine in Australia supplying this material is Blue Circle Southern's Marulan operation near Goulburn in New South Wales.

IRON ORE

The Marulan deposit has reserves of 300 million tonnes. This is sufficient for 100 years' of cement production.

Raw

Materials

The Marulan operation supplies a high grade calcite as a raw material for the manufacture of cement at Blue Circle Southern's Berrima and Maldon works. It also supplies calcite to the BHP steelworks at Port Kembla and for the manufacture of quicklime and hydrated lime on the Marulan site.

GYPSUM

Blue Circle Southern also operates a mine at Waurn Ponds, near Geelong in Victoria, to supply raw material to the adjacent cement works. Here, however, sections of the deposit contain much of the other mineral content needed to make cement and often only sand is needed to bring it to the correct chemistry.

CLINKER

The Waurn Ponds deposit has reserves of approximately 88 million tonnes, sufficient for 90 years of cement production.

Selected materials are often added to Portland cements to enhance desired properties.

COAL

These materials include fly ash, granulated blast furnace slag and silica fume. Fly ashes have little or no cementitious qualities of their own, but react when added to cements in concrete and mortar. Fly ash is a by-product of blackcoal-fired power stations.

More recent is the re-introduction and development of cements using ground granulated blast furnace slag, a by-product of iron making. This slag has cementitious properties of its own, as the raw material and production process of iron making is similar to the cement manufacturing process.

CEMENT

In Australia, Blue Circle Southern Cement proudly pioneered the development of these new cements.

Blue Circle Southern: pioneering new cements

Major equipment used in cement manufacture

The Rotary Kiln is one of the largest pieces of equipment on any cement works. Large steel tubes mounted on rollers and driven by electric motors, turn slowly. Previously prepared raw material is fed into the kiln as it rotates. The kiln is set on a slight slope to assist the raw materials' passage down its length.

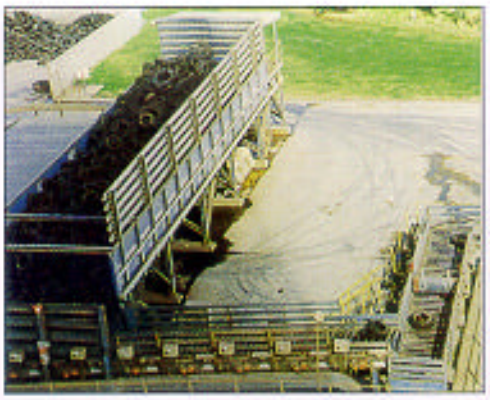
During the passage down the kiln, intense heat is introduced into the opposite end of the kiln. The burning process causes chemical and physical changes in the raw materials resulting in the formation of Portland cement clinker. Kilns are lined with special refractory bricks to protect the steel shell from the high temperatures. Blue Circle Southern's largest capacity kiln is its energy-efficient, dry process kiln at Berrima, NSW. This kiln can produce three quarters of a million tonnes of cement clinker a year.

BCSC Rotary Kiln at Waurn Ponds

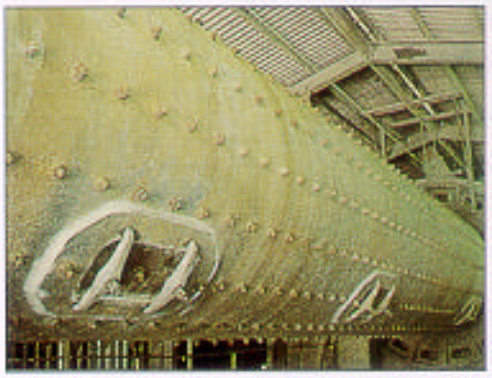
Preheaters are used to pre-heat the raw material before it enters the kiln, using exhaust gases drawn from the kiln when the dry process is used. In its 25 second journey through the preheater, the raw material is heated to a temperature of about 800^{o} Celsius.

Firing the Kiln can involve the use of coal, natural gas or fuel oil. The firing system, at the discharge end of the kiln, introduces the fuel. Heat from the burning fuel converts the raw material to cement clinker. To help, hot combustion gases are drawn the length of the kiln by exhaust fans at the kiln's feed end.

Grinding cooled clinker from the kiln produces the familiar grey and off-white cement powders. This is done in large, rotating cylinders partly filled with steel balls. Balls range from 100mm to 20mm in size. Tumbling balls grind the clinker to a cement of the required fineness. Modern cement plants with closed circuit milling use high efficiency separators to extract cement particles ground to the correct degree of fineness. Oversized particles return to the mill for further grinding. Electric motors of up to 3400 kilowatts drive Blue Circle Southern's largest ball mills.



At Waurn Ponds tyres are used as a supplementary fuel



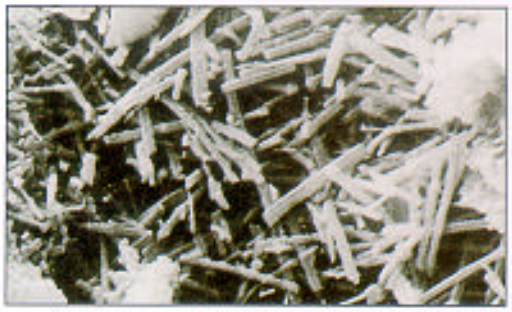
BCSC's rotating grinding cylinder

Dust Collection and suppression are important to operating a cement works. Cement dust escaping into the air would be a wasteful nuisance. Of the many dust collectors used, one of the latest is the electrostatic precipitator. Electrostatic precipitators remove dust from exhaust air in the manufacturing process. Dust-laden air passes through a field of electrically charged metal plates. Dust is attracted to the plates and returned to the process assuring only clean air goes into the atmosphere.

Scanning electron microscopy allows us to see the result of the chemical reactions which take place during hydration

After one day, hydration produces Calcium Silicate hydrates (seen here as a fibrous structure) as well as Calcium Hydroxide (seen here as hexagonal plates).

After two days, hydration has progressed and Calcium Silicate hydrates and Ettringite are seen. The Ettringite appears as fine needles.



At seven days, coarse rods of Ettringite can be seen.

After 14 days, the Ettringite is converting to Mono-Sulphoaluminate, seen here as plates.

At 28 days, the hydrates form an extremely dense structure of Calcium Silicate hydrates.

Cement could be called 'dehydrated rock'. If no water is added to cement it would stay in its powdered form. The magic of cement starts when water is added.

Adding water to cement powder causes 'hydration' to commence. Hydration of cement is a chemical reaction which results in physical and chemical changes. It may seem the chemical reactions are taking place slowly because cement pastes remain workable for some time. In fact, when water is added, some very rapid changes take place immediately.

Water reacts with minerals in the cement to form a gel. This gel is not the soft, spongy type, but belongs to a family of 'rigid' gels, or fibrils. These fibrils grow and become interwoven, forming interlocking bonds.

To produce concrete, sand and aggregate are mixed with cement. The fine cement powder finds its way into the spaces between the gravel and sand. The gel and fibrils form, interlocking with the sand and aggregate surfaces, to bind the mass together.

To the naked eye, the first sign of this process is when the mix starts to set. At this early stage, the fibrils are still relatively weak, but grow in strength and complexity as hydration progresses.

To make sure hydration does not cease, newly-laid concrete is kept moist, or sprayed with water, for several days. This is known as 'curing'.

How cements work

How cement performs in structure

The Glebe Island Bridge, Sydney

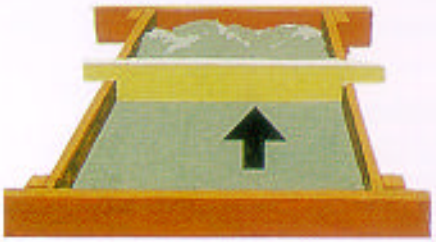


figure 1

figure 2

figure 3

Concrete, when first made, is a fluid material which needs to be confined in a mould until it sets (figure 1). In large works, such as bridges and dams, the mould is a large and specialised construction project in its own right.

When hardened and cured, concrete is very strong, particularly in compression, but less so in tension. For example, a beam when loaded, compresses on its top side while the bottom tends to stretch from tension. The concrete beam shown here (figure 2) illustrates that characteristic.

To strengthen a concrete structure underneath - enhancing its compressed strength - reinforcing steel is built into the concrete structure (figure 3). The hooked ends of the reinforcing steel rod transfer the weight load from the concrete out onto the reinforcement.

Performance

Packaging

With Blue Circle Southern's modern facilities, packaging cement is fully automated using the innovative self-sealing cement paper sack. Strong multi-wall paper sacks with plastic liners are sealed while still empty - leaving just a small valve opening. Paper sacks are held in an applicator able to 'shoot' the sack onto a filling spout where the sack is automatically filled to the correct weight and released from the machine. As the filled paper sack drops from the machine, the movement of the cement inside closes the filling valve, sealing the cement inside to successfully protect product quality.

From packaging....

A packing machine, such as that at the Maldon Works, can process over 2000 paper sacks an hour, about 100 tonnes of product. Sacks pass through a de-dusting station, then to an automatic stacker and palletiser. Pallets of packaged cement can be further protected by shrink-wrapping if necessary.

... to the automatic stacker and palletiser...

... to delivery - Blue Circle Southern was a major contributor to the design and introduction of the B-Double vehicle in New South Wales.

The company also commands sophisticated computerised blending capabilities giving Blue Circle Southern customers ready access to a range of specialised products.

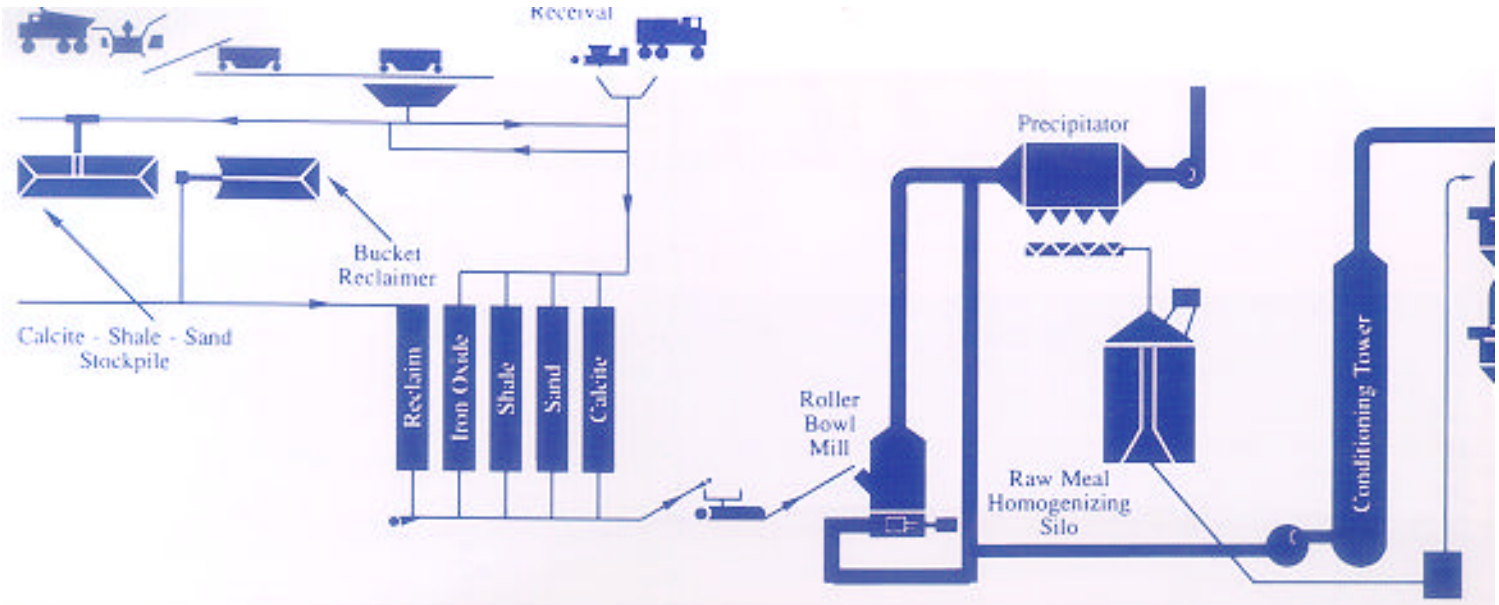
Blue Circle Southern's modern despatch locations highlight the Company's dedication to distribution efficiency and customer service.

Blue Circle Southern products are available from both rural and metropolitan centres - ensuring prompt and reliable delivery, by road and rail, for bagged or bulk products respectively.

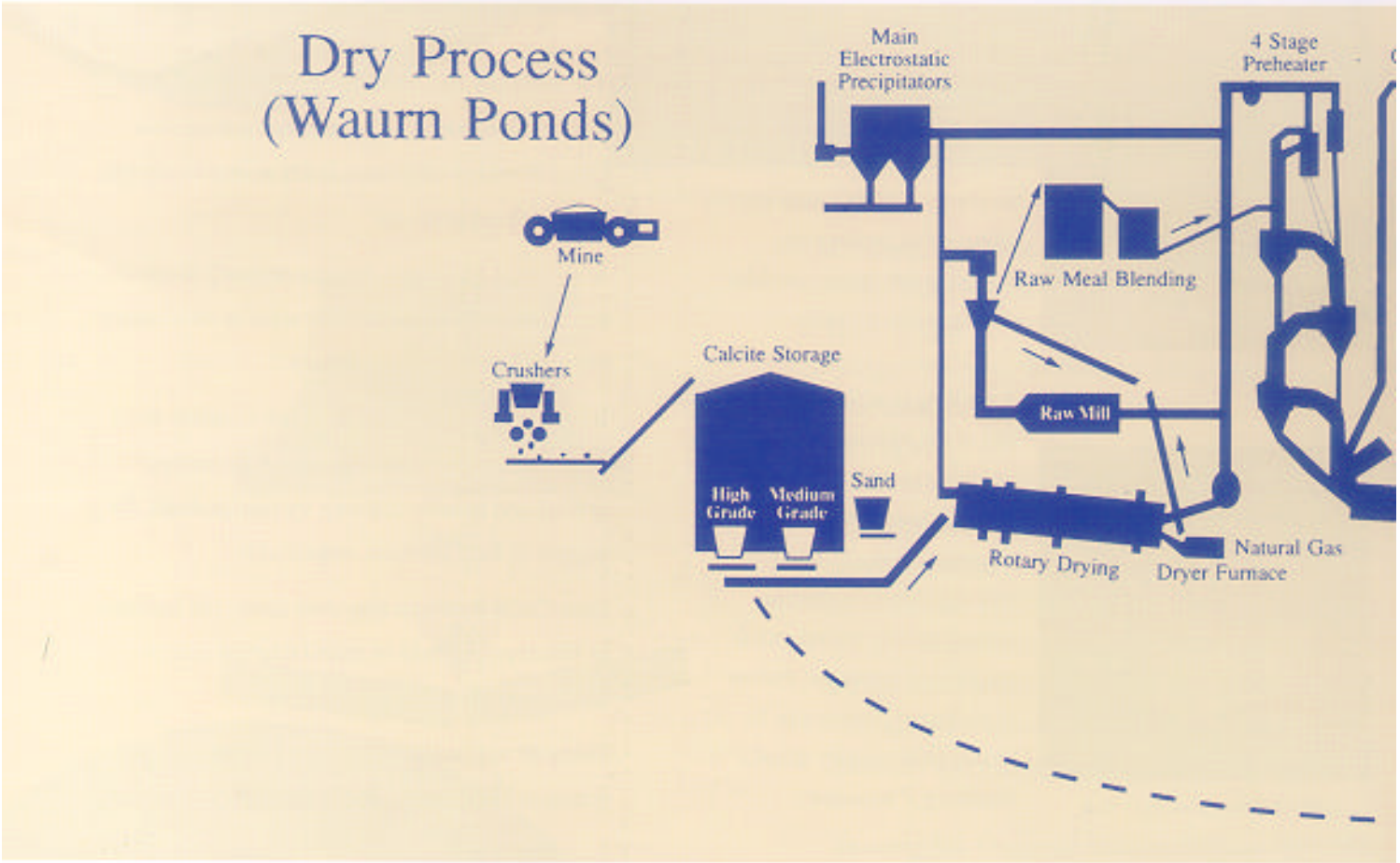
Blue Circle Southern uses dual gauge rail facilities to effectively deliver to manufacturing centres throughout the eastern States.

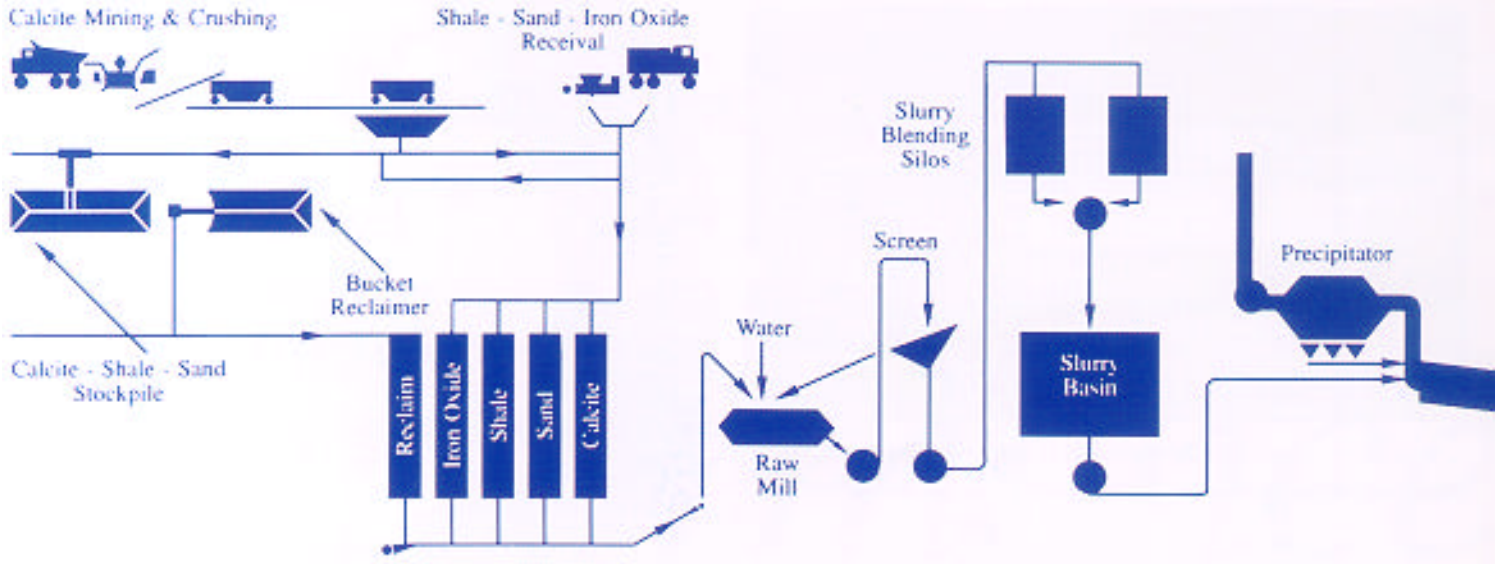
Fleets of well-maintained, reliable vehicles transport bulk and bagged product to customers.

Packaging & Distribution

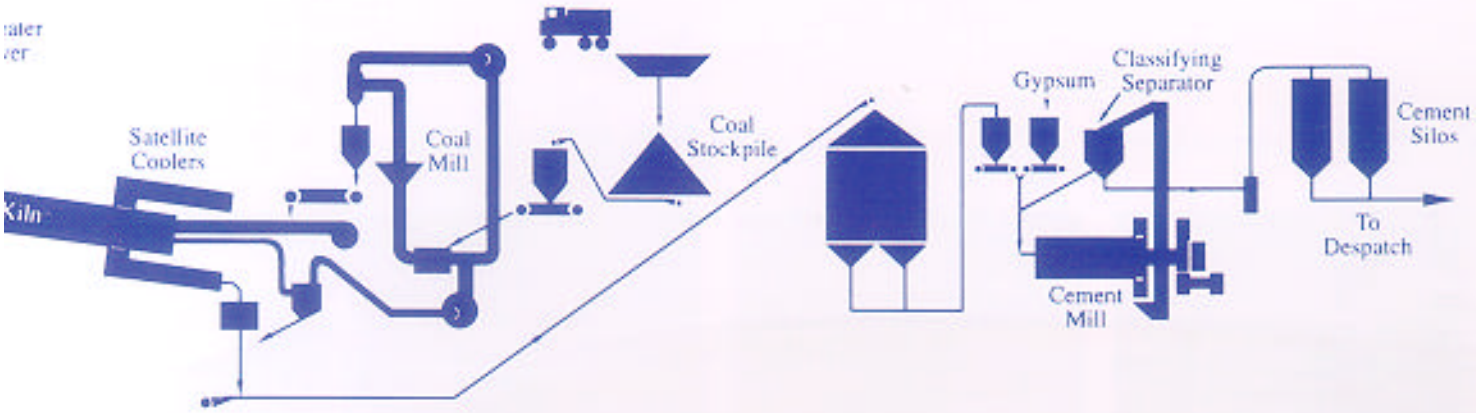


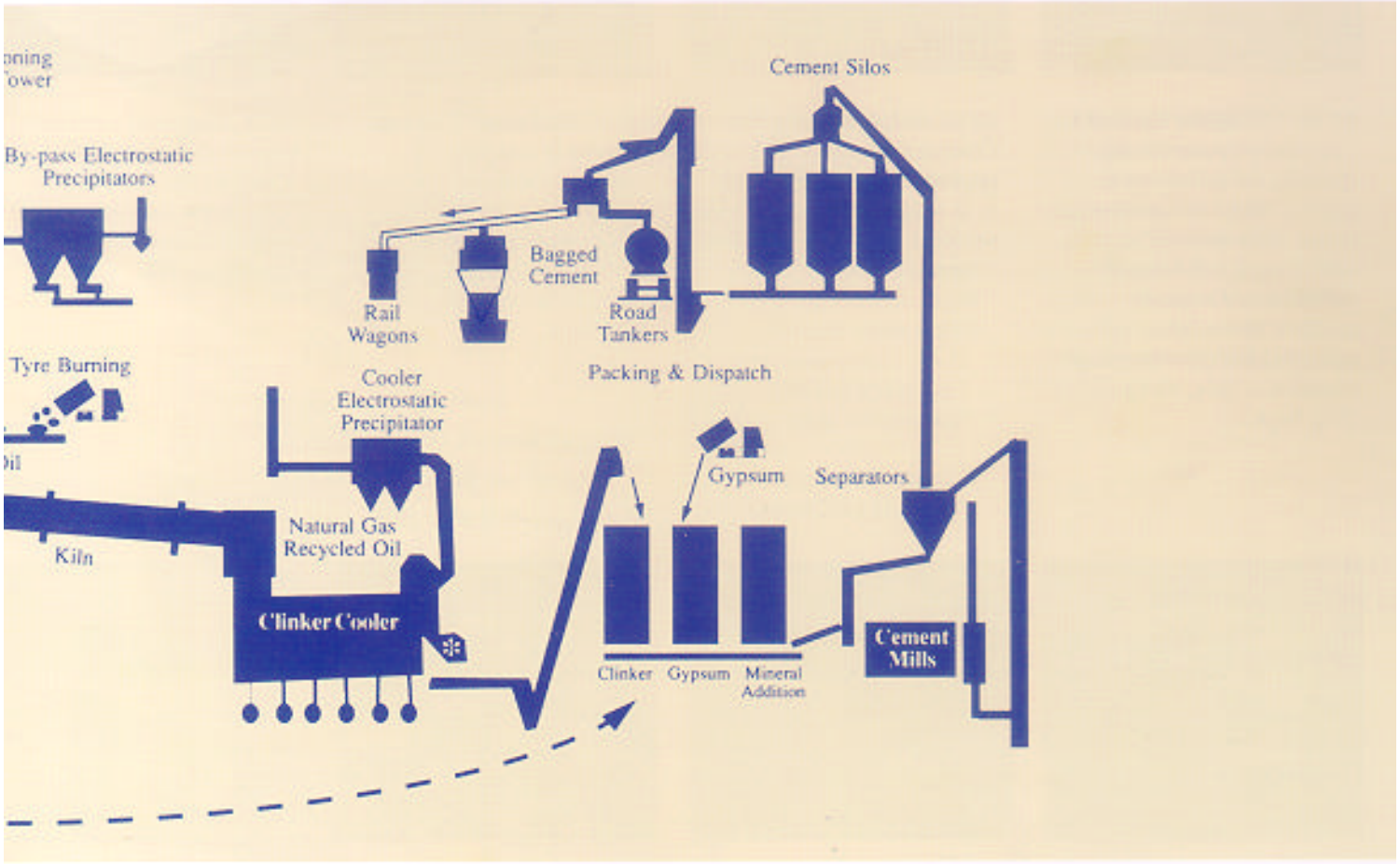
Dry Process (Waurn Ponds)



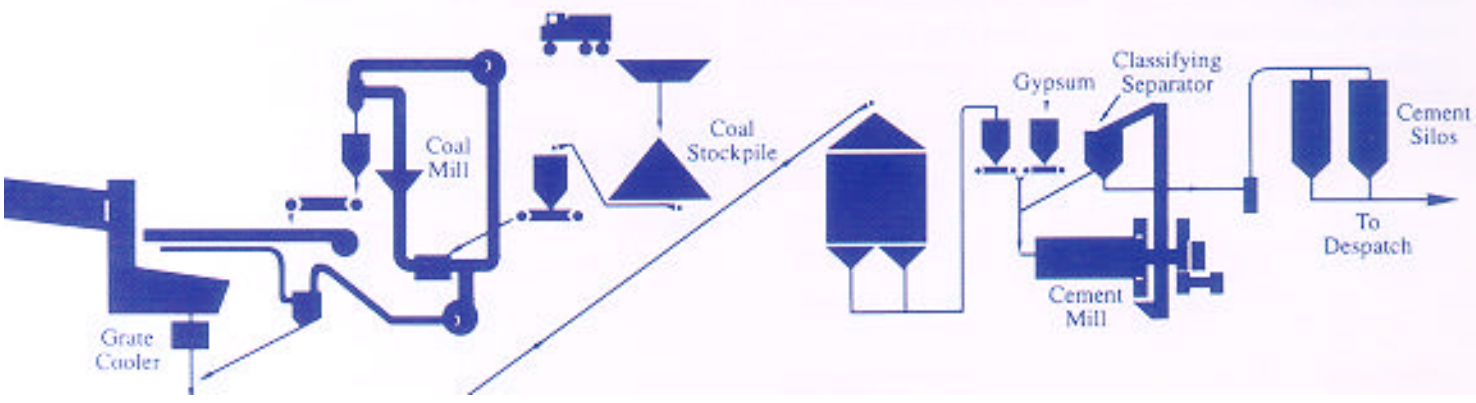


Dry Process (Berrima)

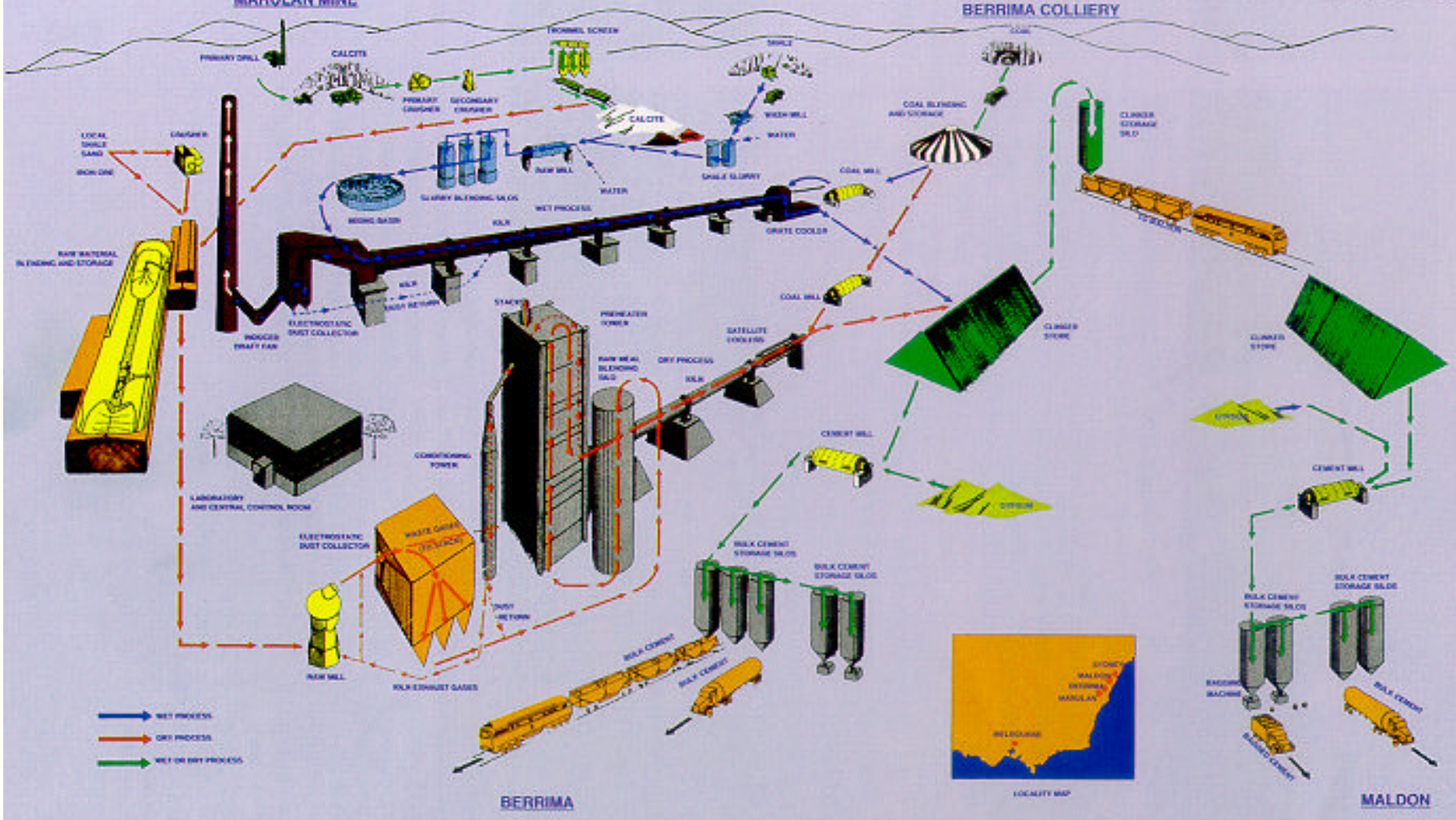




Wet Process (Maldon & Berrima)



THE MARULAN-BERRIMA-MALDON PRODUCTION LINE:



Marulan mine provides the Calcite
Berrima works manufactures the clinker,
Maldon works grinds the clinker to cement

Marulan Mine
Calcite Annual Capacity
3.5 million tonnes

Berrima Works

Wet Process

Raw Material Storage		25000 tonnes
Raw Mill Nos. 1 & 2	kw	600 each
	tph	50 each
	type	Ball
Slurry Blending and Storage		6400 tonnes
Kiln	length	171 metres
	diameter	4.65 metres
	tph	57
Clinker Cooler	length	24 metres
	width	2.4 metres
Coal Mill	kw	600
	tph	20
	type	Ball

Dry Process

Raw Material Blending and Storage		2 x 22000 tonnes
Raw Mill	kw	1700
	tph	200
	type	Roller
Raw Meal Blending		10000 tonnes
Kiln	length	85/111.7 metres (with co
	diameter	5.0 metres
	tph	100
Clinker Cooler	length	22.6 metres
	diameter	2.1 metres
	number	10
Coal Mill	kw	600
	tph	20
	type	Ball

Common Facilities

Coal Blending and Storage	2 x 8000 tonnes
Clinker Storage	90000 tonnes

Berrima Cement Mill

No.5	kw	1500
	tph	40
No.6	kw	3400
	tph	100

Maldon Works

Clinker Storage		30000 tonnes
Cement Mill No.2	kw	2380
	tph	58
No.3	kw	3400
	tph	100

Cements designed for the 21st century and beyond

21st

Cements designed by Blue Circle Southern are continually delivering some of the most exciting innovations in cement history.

Blue Circle Southern's cement technologists can extend the basic process by selecting and controlling the method to produce cements with special properties for specific applications.

Cement, as a construction medium, is unique. Cement delivers a building material which need not ask the building's design to conform to the materials.

Instead, cements designed by Blue Circle Southern have the flexibility to be able to adapt their own inherent characteristics to match the project's unique character.

BCSC Builders Cement is a high quality construction cement containing selected ground granulated blast furnace slag. An alternative to General Purpose Cement, it reduces the need for liquid plasticisers and meets a wide range of domestic, commercial and industrial uses with high strength and durability.
Builders Cement is supplied in 40kg and 20kg bags.

BCSC High Early Strength Cement is used where early strength requirements are specified, such as in manufactured concrete products. It does not contain calcium chloride or any other accelerating additive. Supplied in bulk, 40kg and 20kg bags.

BCSC General Purpose Cement is an ordinary Portland cement of grey colour, for a wide range of general applications where exceptional properties are not required. General Purpose Cement is supplied in bulk, 40kg and 20kg bags.

BCSC Marine Cement is a specially manufactured cement designed for use in marine and other aggressive sulphate and chloride environments, such as seawalls. This cement was used in the immersed tubes of the Sydney Harbour Tunnel. Supplied in bulk, 40kg and 20kg bags.

century and

BCSC Off-White Cement is a general purpose cement specially manufactured to produce an attractive off-white colour. It is used for architectural finishes and manufactured masonry products where achieving a particular colour is important. Supplied in bulk, 40 kg and 20kg bags.

BCSC Sulphate Resisting Cement is designed for sulphate environments, such as in sewage treatment works. Supplied in bulk, 40kg and 20kg bags.

BCSC Shrinkage Limited Cement is designed to produce concrete of low drying shrinkage for civil engineering applications such as roads and bridges. Supplied in bulk, 40kg and 20kg bags.

BCSC Slagment contains slag and complies with AS3972-1991. It is a replacement for General Purpose Cement and is supplied in bulk.

BCSC Pozzoment is a versatile substitute for general purpose cement for uses including bricklaying, rendering, concreting and general stabilisation. It provides improved workability. Pozzoment is supplied in bulk and in 40kg bags.

BCSC Low Heat Cement produces low heat of hydration and low temperature rise in concrete. It is used for mass concrete work, such as in dams and large areas of footing. Supplied in bulk, 40kg and 20kg bags.

BCSC Hydrated Lime is an important agent used for a wide range of domestic, construction and industrial projects. This product is valuable for its ability to adjust the pH balance in garden soils, control the chemical balance in septic tanks and act as a plasticiser in masonry. Hydrated Lime is essential in mortar to promote rebonding and prevent water ingress. Supplied in bulk and 20kg bags.

BCSC Plaster Lime is a premium-grade hydrated lime especially suited to plastering and rendering, fully tested before release. Its chemical purity, working consistency and easy application make it the best choice for set wall and ceiling finishes. Used alone or in combination with suitable gypsum plaster, it is ideal for hard wall applications. Supplied in 20kg bags.

beyond

BCSC Pave-Lok is a jointing material specially formulated to allow rapid filling of vertical joints between segmental clay and masonry pavers. For use on flexible pavements only. This product conforms with specifications of the Clay Brick and Paver Institute and the Concrete Masonry Association of Australia. Pave-Lok is supplied in 30kg bags.

BCSC SSC40 is a special purpose cement designed for the stabilisation of in-situ or select materials. Typically, SSC40 Cement is used in road building, for industrial pavements and storage areas. Selecting a stabilisation product is based on the soil type, the working window requirement and the necessary rate of strength development. SSC40 is supplied in bulk.

BCSC Stabilment, as with SSC40 Cement, is specifically designed for stabilisation. Stabilment offers a long working window with the unique ability to be re-worked, without loss of strength. Stabilment particularly suits large scale road projects, where gradual strength development is an advantage. Stabilment is supplied in bulk.

COLOUR GUIDE

3% Pigment in Grey Cement. A selection from the wide range of oxides available.

RED

YELLOW

BROWN

BLACK

GREEN

BCSC Colouring oxides allow designers unlimited options for unique and aesthetically desirable cement tones.
Manufacturers of cement products use oxides in making surface - and through-colour products. Oxides produce attractive mortars for homes and landscaping.
The variety of effects for paths and driveways in modern pattern-paving makes oxides popular for their practical beauty.
A wide range of colours is available in 20kg and 25kg packs.

Cements designed for the 21st century and beyond

Blue Circle Southern: people & places

Calcite Mine, Marulan

Blue Circle Southern carries a role greater than just the manufacture of cement. There are people to develop and the environment to protect. Blue Circle Southern takes an active role in the community and in working to protect our environment.

Strict chemical and technical controls in the manufacturing process ensue that reliable cements are produced economically.

Yet it is equally important that our manufacturing methods are socially and environmentally responsible. It is vital that our natural resources are utilised effectively - not just for today but always.

Environmental considerations span every aspect of cement making: from location of operations, to strict controls on noise and dust, to rehabilitation and landscaping.

At Marulan and Waurn Ponds mines, plans to rehabilitate worked areas are put in place *before* raw materials are even taken from the ground. All worked areas of a mine are landscaped and revegetated.

At Marulan, seeds collected from shrubs and trees in the area *before* mining are raised in a special nursery. With this level of care, rehabilitated areas of the mine are restored to their original state.

Other innovations contribute to the environment. In some locations, areas set aside for future use are turned into reserves or sanctuaries for native plants and animals. This way, land is put to good use before, during and after mining.

As the life of these mines span decades, Blue Circle Southern plans for the needs of society in generations to come. Today's operations, today's developments and today's planning consider every aspect of our future.

Environme

Community

People are also a valuable component of Blue Circle Southern's role: both in our company and our community.

Blue Circle Southern employees are trained to serve our customers' needs and provide a quality product exceeding international standards. More importantly, however, is the job satisfaction of delivering old fashioned customer service. Blue Circle Southern people know the rewards of a job well done.

Blue Circle Southern stays actively involved with people and events in our community, too. Blue Circle Southern demonstrates this interest and support through regular sponsorship of special events, community programs and charities. These few examples highlight the range within Blue Circle's program of public participation.

'Tracks Through Time' Exhibit, Australia Museum, Sydney

We invite you to visit the fascinating ***'Tracks Through Time'*** exhibit. This interactive diorama is on display at the Australian Museum in Sydney. A colourful panorama of sight and sound bringing to life the story of human evolution from its earliest days, proudly sponsored by Blue Circle Southern Cement.

Blue Circle southern actively supports and assists in the building of country helipads to aid the communities in Australia's vast expanse of regional outposts.

The Echidna

Taronga Zoo's Animal Sponsorship programme has allowed Blue Circle Southern to contribute to animal feeding since 1980. A particular favourite of Blue Circle Southern is the Echidna - an industrious Australian animal who digs the earth to feed and fend for its family.

The Bungonia Lookdown

Bungonia Lookdown, near Goulburn, has a spectacular view over the largest slot canyon in Australia. Through a partnership with Blue Circle Southern and the National Parks and Wildlife Service, this area has been upgraded with four viewing platforms, picnic areas, nature trails and signs. A popular area for cavers, it is now safely accessible for the elderly, handicapped and school groups.

Blue Circle Southern: people & places

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