# Green Square Corporate Office Park
# ACAA Technical Paper 2010


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## ABSTRACT

This paper is based on the ACAA award nomination and outlines the key technical elements of the Green Square project including environmentally sustainable development (ESD) innovations, project design and construction challenges and management of project delivery.

Green Square Corporate Office Park is a mixed-use development located in Brisbane's Fortitude Valley. Green Square comprises of a South Tower – 17,700m$^2$ of Property Council of Australia (PCA) A-grade, 5 Star Green Star commercial office space and a North Tower – 23,800m$^2$ of PCA A-grade, 6 Star Green Star commercial office and retail space.

Both towers incorporate innovative technology, such as a gas fired co-generation system, Selective Catalytic Reduction (SCR) technology in the North Tower, resulting in one of the lowest carbon dioxide ($CO_2$) emission rates of any commercial building in Australia. In the South Tower the implementation of air cooled chillers in place of water cooled chillers saves an estimated 32 megalitres of water per annum.

A number of technical challenges were identified. Examples include; the immature nature of the "green" construction industry at the time of construction as well as the implementation of numerous new technologies saw the need for innovative solutions. These were overcome through stringent material selection, real-time modelling, and highly strategic building commissioning practices.

Leadership and management of the project team was through collaborative contracting, not traditionally used within a design and construct contract. Meeting project targets was rigorously supported by the project team as a whole and while the leadership team focused heavily on ESD and innovation, they always maintained the core values of safety and heath, community, environment, quality, industrial relations and cost and time.



## KEY WORDS

ACAA, air cooled chillers, Brisbane City Council (BCC), Carbon Monoxide (CO2), co-generation, collaborative contracting, commissioning, concrete, design and construct, energy, environmentally sustainable development (ESD), façade, Green Building Council of Australia (GBCA), Green Square, Green Star, indoor environment quality, Leighton Contractors, Leighton Properties, Meva system, National Australian Built Environment Rating System (NABERS), Nitrous Oxide (Nox), North Tower, post tensioning, recycling, Selective Catalytic Reduction (SCR), South Tower, structure, target, water.



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## INTRODUCTION

The $150 million Green Square mixed-use development has incorporated many Australian firsts in building sustainability.

It is a national pioneer in ESD, with North Tower in particular achieving world leadership status in its ratings.

Green Square provides its tenants with healthier and more efficient workplaces while contributing to a cleaner, greener Brisbane.

Key elements of the project's success include:

- The first large scale, gas fired co-generation system in an Australian commercial office building.
- The first Selective Catalytic Reduction (SCR) technology in an Australian commercial office building. This system reduces harmful emissions including nitrous oxide (by 90%) and carbon monoxide (by 85%).
- One of the lowest carbon dioxide ($CO_2$) emission rates of any commercial building in Australia. Green Square produces 75% less $CO_2$ than a standard 4 Star NABERS rated Queensland office building.
- Extensive water savings through efficient fixtures, fittings and harvesting resulting in an annual water saving of 4.4 million litres per annum (1.7 million litres for South Tower and 2.7 million litres for North Tower).
- An additional saving of 32 million litres of water per annum through the installation of air cooled chillers in the South Tower.
- Exceptional, automated indoor environmental quality, with smart lighting and dedicated attention to user comfort.
- Extensive use of modelling to test best practice approaches. Ten different kinds of modelling took place, including computational fluid dynamic and thermal comfort modelling to simulate real time building occupation.
- Continued monitoring for 12 months after practical completion, a particularly innovative approach as it allowed the project team to observe a live building through all seasons and make adjustments to continuously improve performance.
- Significant research and development in new technologies, as a foundation of innovation including volatile organic compounds reduction, $CO_2$ reduction, material selection and energy and water monitoring.
- 90% total recycling of construction waste and use of 60% recycled steel.
- The education and encouragement of suppliers and subcontractors on materials requirements, resulting in greater numbers of Queensland suppliers producing greener materials.
- Transport, land use and ecology sustainability initiatives including a bicycle centre with full end-of-trip facilities.
- No industrial issues or work stoppages throughout the project.
- Project completed under time and within budget (South Tower completed two months early and North Tower three months early).

## SCOPE OF WORKS

The $150 million Green Square development was the vision of land owners Brisbane City Council (BCC) and developer Leighton Properties. This vision became the largest corporate office park developed in Brisbane in the past 15 years.

Located at 515 St Paul's Terrace in the heart of Brisbane's Fortitude Valley, the property abuts the northern rail line to the south, the Fortitude Valley State School to the east, and a residential and commercial mix across the road to the west. Green Square has lead Fortitude Valley's regeneration as a commercial hub and significant alternative for businesses to Brisbane's CBD.

Green Square's master plan comprises:

- South Tower – 17,700m$^2$ of Property Council of Australia (PCA) A-grade, 5 Star commercial space
- North Tower – 23,800m$^2$ of PCA A-grade, 6 Star commercial and retail space
- a 2,500m$^2$ high-tech utility building
- child care facilities and a community centre
- a residential precinct.

**Green Square South Tower**

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|---|---|
| Commenced: | November 2005 |
| Completed: | August 2007 (two months ahead of schedule) |
| NLA: | 17,700m$^2$ |
| Levels: | 5 |
| Other features: | Retail area with adjacent plaza, two levels of basement car parking, secure cycle racks and end-of-trip facilities |
| Tenant: | Brisbane City Council |
| Ratings: | GBCA – Queensland's first 5 Star Green Star Design and As Built v2 (Australian leadership standard) |
| | GBCA – 4 Star Interiors rating |
| | NABERS – 5 Star predicted rating (provisional As Built) |

**Green Square North Tower**

| | |
|---|---|
| Commenced: | December 2006 |
| Completed: | July 2008 (three months ahead of schedule) |
| NLA: | 23,800m$^2$ |
| Levels: | 12 |
| Other features: | Australia's first operational co-generation plant in a commercial building, 610m$^2$ of retail, two levels of basement car parking, secure cycle racks with end-of-trip facilities |
| Tenants: | Queensland Government, Cardno |
| Ratings: | GBCA – Queensland's first 6 Star Green Star As Built v2 (world leadership standard) |
| | GBCA – 4 Star Interiors rating |
| | NABERS – 5 Star predicted rating (provisional As Built) |

**Leighton Contractors' scope for the Green Square project included:**

- assist Leighton Properties with the management of the subdivision from nine lots to five of the section of land at St Paul's Terrace, Fortitude Valley, Brisbane
- design and construction (D&C) of Green Square Close, an internal road with associated infrastructure and services
- construction of 'The Shed', a BCC utility building housing BCC light industrial users such as City Building and Maintenance Services; City Design's

Laboratory Services and Vegetation Pest Services

- D&C of South Tower and North Tower commercial office buildings.

As part of the development structure, the two remaining lots were returned to BCC for future development of low-cost housing, a child care centre and a community centre. This is currently under construction and will complete the Green Square Precinct.

With a capital value of $150 million, Green Square is one of Queensland's largest sustainable urban renewal projects to date. Both South and North Towers incorporate smarter, greener building technologies compared to the majority of office buildings in Australia and have set new standards in sustainable building practices.

## TYPE OF CONTRACT

The Green Square project was managed using a Design and Construct (D&C) model. The staged delivery of both South and North Towers resulted in a number of cost and staffing efficiencies by sharing safety, commercial and design resources, led by the Project Director. The cohesive and streamlined nature of this project delivery ensured that lessons learned were translated effectively from South Tower to North Tower, ensuring meaningful continuous improvement throughout the project.

It also ensured many of the key relationships from South Tower were carried to North Tower, including the architect, structural engineer, mechanical and electrical design and construct contractors, and structural trades.

While the contract delivery remained as a traditional D&C, Leighton Contractors used alliancing principles to integrate the team. The Project Leadership team incorporated a formal relationship management process at both the client and subcontractor levels, resulting in a relationship-based culture that promoted open communication, accountability and innovation among the whole project team.

## TECHNICAL INNOVATION

Green Square North Tower Implemented the first gas fired co-generation system in an Australian commercial office building; the first Selective Catalytic Reduction (SCR) system in an Australian commercial office building; and has one of the lowest $CO_2$ emission rates of any commercial building in Australia.

To put it in context, a typical 4 Star NABERS rated building has a $CO_2$ emission of 110kg $CO_2/m^2$/per annum, compared to North Tower's emissions of only 29kg $CO_2/m^2$/per annum. The building therefore produces 81kg $CO_2/m^2$/per annum less $CO_2$ emissions than that of a standard 4 Star building.

The co-generation plant provides free heat from the generator which is then utilised for the production of chilled water from the air conditioning system through an absorption chiller. This equates to 30% of the Building Peak Load Cooling Capacity.

The co-generation plant also reduces the waste electricity that is lost through the Australian Electrical Grid, as up to 40% of the electricity produced at the power station is lost in transmission to buildings. Another important benefit of the installation of the gas fired co-generation system is that gas $CO_2$ emissions are 75% less than coal $CO_2$ emissions. The plant generates 770 kilowatts of electricity.

With this energy efficient technology, the only concern for the team was the emissions from the generator burning gas within a city centre location; specifically the emissions of nitrous oxide (NOx). The solution to this was the introduction of a SCR system. These systems had historically only been utilised for heavy industry applications. North Tower was the first commercial building in Australia to incorporate

this technology. This SCR system reduces the NOx emissions by 90% and reduces carbon monoxide (CO, another greenhouse gas) emissions by 85%.

A report on emissions is sent monthly to Council so the emissions can be monitored remotely. This entire system developed for the North Tower has now been adopted by Council as best practice and every other co-generation system in Brisbane will need to comply with Green Square North Tower's emission rates.

**ESD features - South Tower**

Project ESD features were implemented within industry standard rating tools such the GBCA Green Star program and the NABERS office energy rating.

Primary elements include:

- Air cooled chillers (as an alternative to water cooled chillers) with an estimated annual water saving of 32 mega litres. Green Square South Tower was the first commercial building in Australia to select the high efficiency Carrier Aquaforce units that offer the additional benefit of 30% less refrigerant than conventional chillers.
- Water efficient fixtures and fittings throughout the building, and rainwater harvesting including a 90,000 litre underground rainwater tank that supplies grey water and direct irrigation. This contributes further to an estimated annual water saving of 1.7 mega litres.
- Recycling included 97% total recycling of construction waste (2,324 tonnes), as well as the use of 60% recycled steel.
- Energy efficient T5 lamps provide illumination and glare control that exceed standard requirements, while the façade system maximises natural light and features light and glare control.
- $CO_2$ reduction of approximately 0.85 million kg of carbon per annum are also forecast through:
    - energy efficient lighting design
    - electronic ballasts
    - small lighting switching zones
    - lower supply air delivery rates
    - population density sensing
    - high efficiency building envelope.
- Indoor environment quality is improved with an efficient ventilation system, the use of low VOC content materials and finishes, and an extended double glazed façade system allowing controlled daylight penetration while reducing solar glare.
- Installation of more than 160 bike racks with shower and change room facilities for tenants, 35 bike racks for public visitors and excellent proximity to public transport is to encourage reduced car use.

**ESD features - North Tower**

Primary elements include:

- Annual water savings of 2.7 million litres through the installation of a 160,000 litre water storage facility for landscape irrigation and on site uses, water efficient fittings and fixtures, waterless urinals and a rainwater system for landscape irrigation.
- A future-proofing blackwater mining facility (should local authorities wish this to be utilised in the future).
- Energy efficient T5 lights, motion sensor lighting in lower-use areas, smart

meters to measure ongoing energy performance and a co-generation plant (discussed prior).

- Recycling of 84% of all on site construction waste (1,295 tonnes), through a dedicated recycling room.
- Use of 40% recycled concrete, 90% recycled steel, 100% plantation or reused timber and alternatives to PVC specified for 60% of major service elements.

## TECHNICAL CHALLENGES AND INNOVATIVE SOLUTIONS

This section focuses on four significant design and construction challenges that were overcome with innovative solutions.

### 1. Contaminated land

Due to this history of mixed and heavy use since the original subdivision in the late 1800's, the site was listed by the EPA as a contaminated site. Extensive site remediation was carried out before the project began in late 2005. The former BCC depot site on St Paul's Terrace was reconfigured to five lots during the early works stage. Of the five lots, three were listed on the Environmental Management Register due to the previous storage of petrochemicals or oil.

Green Square South Tower, located on Lot 1 of the subdivision, required approximately 13,000m³ of excavation work to construct the basements for the building.

The original methodology, based around an earlier soil investigation, indicated that approximately 3,000m³ of contaminated material needed to be disposed of to licensed landfill. Once identified, the contaminated soils were to be stockpiled while a predisposal permit was granted from the EPA.

During the excavation it was discovered that sections of soil previously presumed clean, were potentially contaminated. Until further investigation and validation of the soil could occur, no soil was to be removed from the site. This investigation had the potential to delay the works for up to four weeks. With this delay, the site would be unworkable, as a significant amount of stockpiled soil awaited removal.

With this delay in mind, a cost analysis was completed to establish whether stockpiling the material off-site for analysis and appropriate disposal would be the most cost effective way to move forward. By seeking an alternative solution to manage the contaminated soil removal, bulk earthworks were allowed to continue in a productive manner and prevented program slippage at such an early stage.

### 2. Complex site orientation

Site orientation presented difficulties for maximising daylight penetration and thermal comfort internally. An innovative façade was developed in response to this.

Accurate measurement of solar penetration throughout the year to determine the optimum scale and articulation of sun shading, roof expression and glazing drove the building's shape and form. As a result, the geometry of the building and its modulation generates architecture which is constantly varying in expression.

Large natural precast walls with decorative panels aid in the control of low angled sun penetration, as well as becoming the feature walls that lead through the precinct and identify main entry points. Insitu concrete was used to encapsulate and contain the lightweight sun shading devices, tying together the varying nature of the facades.

### 3. Difficult material selection and availability

Due to specialised sustainability requirements for materials such as concrete, steel, carpets and sealants, another dimension was added to not only design but procurement. Procurement was as much driven by environmental sustainability as it

was by traditional factors of safety, commercial competitiveness and quality.

Materials and finishes could not be selected on colour, texture and quality alone. Material selection became an extremely challenging task, adding an entirely new element to the tendering and tender review process to ensure the materials selected did not compromise stringent ESD targets. This meant educating suppliers and subcontractors on the requirements of material supplied. Evidence of this difficulty was the award for concrete supply. Selection was based primarily on the suppliers' capacity to provide a mix that replaced 40% of the cement material with industrial waste product (known as fly ash), while maintaining workability and quality.

Originally when concrete was tendered for in January 2006, only one supplier could meet the cement replacement content of the concrete mix without adding a premium to the cost.

One year later, three additional concrete suppliers were able to supply the required mix at commercially competitive rates, and were invited to tender for the North Tower. The loss of the original contract due to the inability to meet the requirements of the South Tower specification in a commercially competitive way was a strong driver for each of the suppliers to develop a workable mix which reduces embodied energy and resource depletion.

**4. Building commissioning methodology**

Due to the complexity and originality of the new technologies within the buildings, a comprehensive Commissioning Management Plan was implemented to ensure all building services were checked and operational before practical completion of both South and North Towers. This included the following methodologies:

- The implementation of the Chartered Institute of Building Services Engineers (CIBSE) commissioning methodology, based on an English set of guidelines. Most Australian buildings at the time relied on the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) commissioning methodology.

  The CIBSE method was chosen as it was recognised as being much more transparent and inclusive, covering all services including mechanical, electrical, fire, hydraulic, lifts and lighting. This differed from the ASHRAE method, which only covers mechanical systems of the building.
- Appointing an Independent Commissioning Agent (ICA) for both buildings. This role was created to lead the commissioning process on behalf of the client to confirm adherence to the original intent of the building services.
- Continuous building testing and tuning allowed the project team to observe a live building throughout the seasonal cycle (12 month) rather than just at one point in time. This process allowed for observations to be logged about the systems and data captured. Any problems that occurred within the building were identified and changed immediately, driving energy efficiency even further.

## USE AND DEVELOPMENT OF NEW TECHNOLOGIES

Many of Green Square's landmark achievements are the result of elegant electrical, mechanical, hydraulic and structural engineering solutions. The project team developed and implemented a range of innovations to optimise the design of Green Square as a whole. Key design innovations are listed below.

- **Co-generation technology**. As outlined earlier, North Tower incorporated a co-generation plant comprising a gas powered generator and a vapour absorption chiller. This technology is capable of using an energy source which has a much lower greenhouse gas co-efficient than that of coal. Using

this technology, North Tower's power consumption emissions are around 81kg/$CO_2$/$m^2$/per annum less than a standard 4 Star (NABERS rated) building.

- **Selective Catalytic Reduction technology**. North Tower integrated revolutionary SCR technology to drastically reduce emissions. The integration of this post-combustion control technology reduces North Tower's NOx emissions by a further 90%.
- **Air cooled chillers**. Air cooled chillers in South Tower (as an alternative to water cooled chillers) allow for water savings of 32 million litres per annum.
- **Indoor environmental quality**. Green Square made significant technological advances in the development of indoor environmental quality for occupant wellbeing. Key initiatives included a system that monitors internal air quality and adjusts ventilation rates accordingly, as well as a $CO_2$ monitoring and control system. Additionally, specialised building façades were developed to assist in the control of daylight glare and utilised high frequency ballasts within the lighting system to reduce flicker and eye strain.

  The team mitigated the use of volatile organic compounds (VOC) and the use of materials containing or treated with formaldehyde in the construction and fit out of the buildings. The application of PVC free mains and sub-mains cables was implemented to avoid the use of known toxins and carcinogens which are harmful to human health. The building also features a tenant exhaust riser over internal equipment that produces exhaust fumes.
- **Energy usage**. Green Square's energy innovations result in an energy saving for South Tower of 0.85 million kg of carbon per annum and 1.9 million kg of carbon per annum for North Tower. This equates to a total energy saving of 2,750 tonnes of carbon per annum. This significant saving is attributed to a number of initiatives including:
  - Localised generation of electricity from North Tower's roof-top co-generation plant reduces the demand on the public electric infrastructure network and eliminates energy losses in the transmission of power to the site. In the event of a grid power failure, the same generator also provides standby power in excess of standard requirements.
  - High efficiency single tube T5 luminary lighting systems providing less than 5 W/$m^2$ power densities.
  - Separate switching zones per floor make it possible to individually illuminate occupied areas, while motion sensors operate lighting after hours to avoid unnecessary energy use. External lighting has been designed to reduce urban sky glow and its effects on nocturnal wild life, while still providing safety for late night workers.
  - High efficiency, low temperature, variable air volume (VAV) air distribution lowers energy consumption and improves acoustic performance due to reduced air volumes.
- **Water**. South Tower's use of air cooled chillers saves 32 million litres of water per annum alone. An evaporative condenser cooling system, a 90,000 litre water tank, rain water harvesting, mechanical condensate harvesting, fire test water harvesting and water efficient fixtures and fittings further reduce water consumption by an estimated 1.7 million litres per annum.

  North Tower incorporates water efficient fixtures and fittings combined with a rainwater harvesting system to reduce total water consumption throughout the building. This strategy saves approximately 2.7 million litres per annum of potable water. The tank was purpose built for this application and has been sized to accommodate a minimum of 85,000 litres of rainwater.

Therefore the total combined water saving for both towers is 36.4 million litres per annum.

- **Post tensioning methodology**. The integration of post tensioning and cement replacement methodologies optimised the efficiency and sustainability of the construction of the concrete slabs on the North Tower. Specifically, the combination of these technologies reduced the consumption of concrete required by 24%. Additionally, it reduced reinforcement materials required by 57% through the adoption of post tension methodology.
- **The Meva system**. For South and North Towers the Meva system was employed instead of traditional timber formwork. This resulted in a reduction of approximately 5,500m2 of ply waste which would generally be sent to landfill. The re-usable and recyclable Meva system significantly reduced the environmental impact of Green Square's construction.

## LEADERSHIP AND MANAGEMENT OF PROJECT DELIVERY

Project partners comprised D&C manager Leighton Contractors, developer Leighton Properties and end-user BCC. The formal relationship management process drove shared leadership aspirations and achievements.

### Collaborative contracting

Green Square's project leadership team revolutionised the way D&C contracts are delivered for commercial building projects by engaging in a formal relationship management process. This formal process allowed for a contractual focus on relationships, instead of the traditional juggling of risk.

The Project Director supported the relationship management process wholeheartedly, strongly believing it contributed to moulding a committed project team with aligned goals while driving shared leadership aspirations and personal growth.

Green Square was a D&C contract with Leighton Properties as the client. It is important to note that although Leighton Properties is a Leighton Holdings Limited company, it is a stand alone entity within the Leighton Holdings group and therefore, the commercial relationship was the same as with any other developer. Further, the contract did not require any relationship management processes to be implemented.

One of the primary reasons for implementing a relationship management process was the requirement for both buildings to be Green Star rated. This had not been undertaken before in Queensland, and at the time of entering into the contract, there had only been five certified Green Star projects in Australia. The process was new to all parties including Leighton Contractors, Leighton Properties and BCC. A relationship management process was the best way to foster a collaborative working environment to tackle the uncertainty and challenges presented by the project.

### Management of innovation

Through the project team's management approach and encouragement of open discussion between all parties in a controlled practical format, Green Square was able to achieve some landmark milestones for the Australian construction industry. These include the following:

- **Changing the BCC policy for co-generation and SRC technologies**

Leighton Contractors invested heavily in sustainability education and relationship management with BCC to adopt new sustainable practices.

Before Green Square, BCC had never received an application for a gas fired co-generation plant. Working closely with Council, the project team was responsible for

redefining the Development Application for managing emissions for co-generation. BCC has since adopted this as best practice, and future co-generation systems will need to comply with Green Square North Tower's emission rates.

- **Innovative use of concrete**

The project used a combination of in-situ concrete elements and pre-cast concrete elements for the structure. The intent of the design warranted that the internal columns remain in a natural state to tie in with the scheme for the integrated fit-out. This constraint meant all internal columns were required to be a class two finish with the use of white cement.

To achieve the best possible finish, pre-cast concrete columns were detailed from upper ground to level four. The decision to use pre-cast concrete benefited the project in three ways:

  - Safety – eliminated the use of mobile scaffolding to pour the columns.
  - Program – the pre-cast columns were constructed to span two floors. This allowed the formwork to continue on the next level as soon as the slabs were poured. There was no on site down time that is normally associated with setting up and pouring in-situ columns.
  - Quality of finish – the columns were manufactured off site in a controlled environment enabling the high level of finish required to be achieved.

**Management of the design process**

Leighton Contractors managed the entire design process from concept design to documentation while working closely with Cox Rayner Architects. Successful design outcomes were achieved by ensuring structural and service integrity was intact and the architect's vision was at the core of the design. Key design features include:

- **The layout.** The project creates a multi-use infill linking significant existing precincts including the RNA Showgrounds and Fortitude Valley Railway Station Precinct. The master plan is based on creating a pedestrian spine between these two precincts, part of which is formed as a street. The street is orientated so that it can be extended north to provide accessibility for public transport and for future developments.
- **The façade**. The architectural expressions of the building façade were crafted as a direct response to climate, context and individual users. This response has entailed accurate measurement of solar penetration throughout the year to determine the optimum scale and articulation of sun shading, roof expression and glazing. Both horizontal and vertical sun shading are employed and vary in intensity to suit the particular solar position.
- **The structure**. The building structure is a combination of in-situ, pre-cast concrete and steel. Large natural pre-cast walls with decorative panels aid the control of low angled sun penetration as well as becoming feature walls that lead through the precinct and identify main entry points. In-situ concrete is used to encapsulate and contain the lightweight sun-shading devices, tying together the diverse nature of the facades.

**Management of sustainability outcomes**

The developers and contractors embarked on a whole team approach to push the envelope in relation to ESD, placing significant focus on formalising the management of sustainable initiatives.

A formal methodology was adopted to ensure precise sustainability management. It included the following activities.

- A Green Star accredited professional was appointed to oversee the design, construction and fit out of the building. Leighton Contractors, as part of the

project, had five staff members accredited for Green Star.

- A formal commissioning methodology was developed to establish and implement a new standard in commissioning practices so the new technologies within the building would function at their full potential.
- A formal commissioning testing and fine tuning methodology was implemented once Green Square was operational (quarterly for the initial 12 months) to ensure the buildings operated at full efficiency.
- An independent agent was appointed to oversee the commissioning process and report any issues to relevant stakeholders.
- A building user's guide was published to facilitate usability long after commissioning.
- An environmental management plan was developed to ensure sustainable usage of Green Square's environment.
- A best practice water management system was designed and implemented in an effort to recycle 100% of waste water generated on site.

**Management of training and development initiatives**

The Green Square project offered opportunities for training and professional development for subcontractors and Leighton Contractors' employees.

*Leighton Contractors' employees training and further education*

The project leadership team was committed to providing staff training to improve their professional skills and knowledge set, as well as empowering the team to strive for excellence in sustainable construction. This was particularly important due to the ambitious and innovative nature of the project.

All senior managers attended the GBCA Green Building Professional Accreditation Course during the project. Following the award of Green Building Professional status, these staff made presentations to new candidates of the GBCA course and have also presented at national GBCA events.

*Subcontractor training*

With 'Safety and Health Above All Else' at the forefront of all project participants' minds, it was essential that all subcontractors received accurate and necessary training. Recognising this, the Green Square project team provided a series of opportunities including tickets for working at heights, hoist operation and working on elevated platforms. Fire extinguisher training was also provided by the Queensland Fire and Rescue Service.

## PROJECT TARGETS AND OUTCOMES

To measure KRAs, the project team developed a rating system for a suite of Key Performance Indicators (KPIs) that were instrumental in project delivery and evaluation. These KPIs included: safety and health, environment, ESD, commercial (cost and time), quality, employee and industrial relations, community relations and relationship management.

**Safety and health**

Green Square's safety policies and philosophies were built upon the very high standard demanded by Leighton Contractors for all its projects, and founded on processes outlined in its knowledge management system, The Leighton Way. There was an immediate focus on safety from the start of the project, actively led by the leadership team.

Best practice safety standards, coupled with key initiatives, ensured safety.

The key initiatives included:

- Management System Documents. The Green Square System Documentation Schedule and Responsibility Matrix contained all documents required for effective safety procedures.
- Safety, Health and Environmental Incident Management, a web based reporting system for incident management.
- Induction and training for all project personnel.
- Rigorous review and approval process for Safe Work Method Statements associated with every activity on site.
- Periodic reviews of the management system were handled using a system of scheduled audits to ensure that all aspects of the system were up to date and relevant.
- A Safety in Design Workshop was held early in the design process for both South and North Towers to identify key risk areas across construction, operation and maintenance.
- The Critical Behaviour Assessment (CBA) process was implemented with Leighton Contractors' site staff on a fortnightly basis from the commencement of the project.
- Discussions with the Safety Committee empowered the workforce as they were given the opportunity to identify key risk areas on site.
- Subcontractors and their employees were recognised for their contribution to the safety and health effort both formally and informally.

**Environment**

As Green Square is a mixed-use redevelopment of a former industrial site, rigorous environmental standards applied to each building type. These standards included Leighton Contractors' world best practice accreditation to ISO14001, as well as implementation of the project Environmental Management Plan.

Environmental performance and work instructions were continuously monitored and reviewed with the aim of eliminating risk and ensuring continual improvement. Employees were responsible for complying with instructions, rectifying or reporting harmful environmental conditions, and actively participating in environmental meetings and training sessions.

Other standards included:

- Environmental Management Plan (EMP) – addressed environmental management strategies.
- Environmental audits – included in the Project Audit Schedule to ensure adherence to environmental targets.
- The implementation of a robust building management methodology to maximise efficiency in the operation of new technology.
- Extensive education was provided to all project participants including formal education through the GBCA's Green Star Accredited Professionals Course.
- A strong, sharing culture was developed through good communication and team building, resulting in workers suggesting environment-related initiatives.

**ESD**

*Green Building Council of Australia (GBCA) rating*

The Green Star environmental rating system, through the GBCA, is a system for evaluating the environmental performance of Australian buildings based on a number of criteria, including energy and water efficiency, quality of indoor environments and resource conservation.

Green Square won a number of significant honours from the GBCA: Queensland's first 5 Star Green Star Design and As Built v2; 4 Star Green Star interiors rating (South Tower) and Queensland's first 6 Star Green Star As Built v2 (North Tower).

The development earned these prestigious ratings by demonstrating how innovations in ESD can be included in all aspects of a project, including planning, design, demolition, construction and fit out, while still being on time and on budget.

*National Australian Built Environment Rating System (NABERS) for energy efficiency*

NABERS is a national initiative managed by the NSW Department of Environment, Climate Change and Water. NABERS is a performance-based rating system that rates a building on the basis of its measured operational impacts on the environment.

South Tower originally targeted a 4 Star predicted NABERS rating and once again accomplished above this with a 5 Star predicted NABERS rating provisional on As Built. Green Square North Tower targeted a rating of 4.5 Star predicted NABERS rating, achieving a 5 Star predicted NABERS rating provisional on As Built.

**Commercial (cost and time)**

Green Square was a financial success for contractor Leighton Contractors, developer Leighton Properties and subcontractors.

Both towers were handed over well in advance of the approved practical completion dates, with Green Square South Tower completed two months early, and Green Square North Tower completed three months early. Some of the time saving techniques included:

- Program workshops - run by an independent organisation and implemented eight and nine months prior to practical completion.
- Project Completion Plan - listed processes to ensure the contractual requirements were fulfilled and a smooth delivery
- Commissioning Program - due to the complexity of commissioning, a separate program was adopted and monitored weekly
- Post occupancy strategy - Once practical completion was achieved, the project aimed to close out any defects promptly

**Quality**

To achieve an outstanding performance in the Quality KPI, a robust Quality Management System was established to set specific targets and initiatives to ensure Quality met the requirements of AS/NZS 9001:200 Quality Management Systems Standard. Examples include:

- Work Improvement Notice (WIN) System - implemented to report non-conformances and improvements for Safety, Quality, Environment, Design, Construction and Community.
- Project Audit Schedule - created at the commencement of both towers to monitor the progress of the project.
- SAI Global Audit - SAI Global reported no major non-conformances recorded at the Green Square project
- Process Risk Identification - specific risk analyses were performed on all work activities prior to commencing the work

**Community**

Leighton Properties and Leighton Contractors, as developers and builders of Green Square, proactively managed stakeholder and community consultation and integration. Due to the ground-breaking nature of the project, the team conducted community consultation to a level not commonly seen for commercial building projects.

- A 24 hour community hotline in place for the community to call any time.
- Fortitude Valley State School, adjoining the development, was involved in the development process through fortnightly liaison meetings with the school's Principal and Parents and Friends Association.
- Project newsletters were introduced early to engage the community, workforce and other stakeholders.
- The design and development process was conducted in regular consultation with BCC's Urban Renewal Brisbane (formerly Urban Renewal Task Force).

**Employee and industrial relations**

Leighton Contractors worked closely with local union officials and implemented systems to prevent any industrial relations issues or delays. The project team's successful industrial relations included regular meetings with key union representatives, comprehensive reporting systems and involvement of the Builders Labourers Federation, Construction, Forestry, Mining and Energy Union, Construction Safety Unit and Department of Industrial Relations in monthly site-wide safety communications events.

**Relationship management**

The project leadership team was determined from the start to develop a strong and open team culture. They achieved this by adopting a number of relationship management initiatives, many of which were not standard practice for buildings but were more commonly used on civil projects.

Exceptional results were achieved through a formal relationship management process on the project. The following initiatives were implemented:

- Project Charter – established at the client/end-user level at the beginning of the project. A Foundation Workshop was held where all parties set objectives and commitments to deliver a successful project.
- Contractors Charter – implemented at the subcontractor level, similar to the Project Charter. This was a set of objectives and commitments made by the subcontractors on deliverables such as profit, time, quality, safety and ESD components.

## CONCLUSIONS

The entire project team understood the magnitude of what they were achieving with sustainable building practices. Despite being a relatively small team, the affect it has had on the construction industry and future building practices is significant.

Lessons learned about new initiatives and technologies developed and implemented at Green Square were circulated to benefit the industry. The team displayed strong leadership by actively seeking opportunities to share their knowledge and experiences.

The GBCA used Green Square as a best practice ESD case study at both national and international conferences. Green Square's Project Director Petie Walker, Project Managers Jamie Kunst and Tony Joslin, Services Manager Mark Sanders and Development Director Andrew Borger, have presented Green Square at numerous industry and education forums.

The ESD initiatives and ground-breaking technologies that were delivered by the team at Green Square were a result of a shared vision and a committed leadership team willing to push the boundaries of sustainable development. The project has instigated an enduring legacy that has reached beyond the construction industry.

Green Square continues to inform greener, smarter buildings being constructed

nationally and internationally. Thanks to Green Square, the benefits of sustainable building will not only be seen today, but long into the future.

## REFERENCES

Nil

Figure 1 below: Shows Green Square Corporate Office Park innovative features.

## Green Square Corporate Office Park innovative features