Australian Heritage Database

Places for Decision

Class : Historic

Identification

List:	**National Heritage List**
Name of Place:	Sydney Harbour Bridge
Other Names:	The Coat Hanger
Place ID:	105888
File No:	1/12/036/0065
Nomination Date:	30/01/2007
Principal Group:	Road Transport

Status

Legal Status:	30/01/2007 - Nominated place
Admin Status:	19/09/2005 - Under assessment by AHC--Australian place

Assessment

Recommendation:	Place meets one or more NHL criteria
Assessor's Comments:	
Other Assessments:	National Trust of Australia (NSW) : Classified by National Trust

Location

Nearest Town:	Dawes Point - Milsons Point
Distance from town (km):	
Direction from town:	
Area (ha):	9
Address:	Bradfield Hwy, Dawes Point - Milsons Point, NSW 2000
LGA:	Sydney City NSW North Sydney City NSW

Location/Boundaries:

Bradfield Highway, Dawes Point in the south and Milsons Point in the north, comprising bridge, including pylons, part of the constructed approaches and parts of Bradfield and Dawes Point Parks, being the area entered in the NSW Heritage Register, listing number 00781, gazetted 25 June 1999, except those parts of this area north of the southern alignment of Fitzroy Street, Milsons Point or south of the northern alignment of Parbury Lane, Dawes Point.

Assessor's Summary of Significance:
The building of the Sydney Harbour Bridge was a major event in Australia's history, representing a pivotal step in the development of modern Sydney and one of Australia's most important cities. The bridge is significant as a symbol of the aspirations of the nation, a focus for the optimistic forecast of a better future following the Great Depression. With the construction of the Sydney Harbour Bridge, Australia was felt to have truly joined the modern age, and the bridge was significant in fostering a sense of collective national pride in the achievement.

The Sydney Harbour Bridge was an important economic and industrial feat in Australia's history and is part of the nationally important story of the development of transport in Australia. The bridge is significant as the most costly engineering achievement in the history of modern Australia, and this was extraordinary feat given that it occurred at the severest point of the Great Depression in Australia.

The bridge is also significant for its aesthetic values. Since its opening in 1932, the Sydney Harbour Bridge has become a famous and enduring national icon, and remains Australia's most identifiable symbol. In its harbour setting, it has been the subject for many of Australia's foremost artists, and has inspired a rich and diverse range of images in a variety of mediums – paintings, etchings, drawings, linocuts, photographs, film, poems, posters, stained glass - from its construction phase through to the present.

The Sydney Harbour Bridge is also significant as one of the world's greatest arch bridges. Although not the longest arch span in the world, its mass and load capacity are greater than other major arch bridges, and no other bridge in Australia compares with the Sydney Harbour Bridge in its technical significance. In comparing Sydney Harbour Bridge with overseas arch bridges, Engineers Australia has drawn attention to its complexity in combining length of span with width and load carrying capacity. The construction of Sydney Harbour Bridge combined available technology with natural advantages provided by the site. The designers took advantage of the sandstone base on which Sydney was built, which enabled them to tie back the support cables during construction of the arch, and to experiment with massive structures. Although designed more than 80 years ago, the bridge has still not reached its loading capacity.

The bridge is also significant for its important association with the work of John Job Crew Bradfield, principal design engineer for the New South Wales Public Works Department, who ranks as one of Australia's greatest civil, structural and transport engineers.

Draft Values:

Criterion	***Values***	***Rating***
A Events, Processes	The building of the Sydney Harbour Bridge as a transport facility linking the city with the north shore was a major event in Australia's history, and represented a pivotal step in the development of modern Sydney and one of Australia's most important cities. The bridge became a symbol for the aspirations of the nation, a focus for 'optimistic prognostications of a better future' following the Depression.	AT

	The bridge represented an important step in transforming the city of Sydney into a modern metropolis. Internationally, the bridge was recognised as a symbol of progress and a vision of a splendid future. The building of the Sydney Harbour Bridge was an important part of the technical revolution of the 1930s and seen as evidence of Australia's industrial maturity. The bridge represented the mechanical age displacing the pastoral and agricultural way of life on which Australia's economy had been based. The scale of the operations was enormous and at the time of its construction, it was the widest long-span bridge in the world. The Sydney Harbour Bridge includes a steel arch spanning the harbour between Milsons Point on the north side and Dawes Point on the south side, and elevated approaches to the arch from both the north and south sides. The arch is made up of two 28-panel arch trusses set in vertical planes, 30 metres apart centre to centre, and braced together laterally. Two granite-faced concrete pylons, with a height of 89 metres above mean sea level, are located at each end of the arch. A deck carrying road and rail traffic is suspended from the arch. Pairs of hangers, ranging in length from 7.3 metres to 58.8 metres, support cross-girders, each weighing 110 tonnes, which support the deck. The northern and southern approaches each contain five spans, constructed as pairs of parallel-chord, six-panel steel trusses. The spans are supported by pairs of concrete piers faced with granite. The combined length of the approach spans is 646 metres. The Sydney Harbour Bridge is an outstanding cultural landmark for the nation and represents a highly significant place in Australia's cultural history. The opening of the Sydney Harbour Bridge was a momentous occasion, drawing remarkable crowds estimated at nearly one million people. Since its opening in 1932, the Sydney Harbour Bridge has become a famous and enduring national icon and symbol of Australia. The bridge remains one of Australia's most identifiable symbols.	
E Aesthetic characteristics	Sydney Harbour Bridge is an integral component of the Sydney Harbour vista and represents one of the most recognisable and iconic images in the world. It is the picturesque blending of the natural environment and man-made structures around the harbour foreshores that has proved an inspiration for generations of artists and writers. In its harbour setting, it has inspired a rich and diverse range of images in a variety of mediums – paintings, etchings,	AT

	drawings, linocuts, photographs, film, poems, posters, stained glass - from the date of its construction through to the present day. The bridge is conceivably one of Australia's most-photographed cultural landmarks, and striking images of the bridge have been captured by some of Australia's best-known photographers. The Sydney Harbour Bridge has also been replicated in tourist posters, postcards, crafts and the folk arts, its image reproduced in media including glass, ceramic, metal, shells and crochet cotton, embroidery and etchings in a huge array of objects.	
F Creative or technical achievement	The Sydney Harbour Bridge may be considered the world's greatest arch bridge. Although not the longest arch span in the world, its mass and load capacity are greater than other major arch bridges. No other bridge in Australia compares in its technical significance with the structure of the Sydney Harbour Bridge and its pylons and constructed approaches between Argyle Street in the south and Arthur Street in the north. The construction of Sydney Harbour Bridge combined available technology with natural advantages provided by the site. The bridge is an outstanding technical and construction achievement of the Twentieth Century. The designers took advantage of the sandstone base on which Sydney was built - which enabled them to tie back the cables during construction of the arch and to experiment with massive structures. Although designed during the 1920s and 1930s the bridge has still not reached its loading capacity.	AT
G Social value	It was part of John Job Crew Bradfield's vision for the bridge that it be used at times of national rejoicing. Since its opening it has regularly supported flags, banners, and especially fireworks, becoming a focus for national and local celebrations. Community ceremonial and celebratory occasions centred on Sydney Harbour Bridge, either for the people of Sydney or the broad Australian community, are well recognised and have been widely noted. Since 1932, the broad Australian community has identified the Sydney Harbour Bridge as one of the most nationally and internationally recognised symbol of Australia and the bridge in its harbour setting represents a composite national symbolic image.	AT
H Significant people	John Job Crew Bradfield ranks with other engineers whose close involvement in a broad range of projects contributed to	AT

Australia's national development. As principal design engineer for the New South Wales Public Works Department, Bradfield was largely responsible for finally bringing the Sydney Harbour Bridge to fruition. As Chief Engineer, he prepared the general design specification and supervised the whole project on behalf of the Government of New South Wales, also integrating the bridge into the Sydney road, tram and rail system.

Bradfield was nationally recognised through his appointments to the Australian National Research Council and the Australian Commonwealth Standards Advisory Committee. The Institution of Engineers, Australia awarded him the Peter Nicol Russell Medal in 1932, and he also received the Kernot Memorial Medal from the University of Melbourne in 1933, and the Telford Gold Medal from the Institution of Civil Engineers, London in 1934.

Historic Themes:
Group: 03 Developing local, regional and national economies
Themes: 03.08 Moving goods and people
Sub-Themes: 03.08.05 Moving goods and people on land

Group: 03 Developing local, regional and national economies
Themes: 03.14 Developing an Australian engineering and construction industry
Sub-Themes: 03.14.02 Using Australian materials in construction
Group: 04 Building settlements, towns and cities
Themes: 04.01 Planning urban settlements
Sub-Themes: 04.01.05 Developing city centres
Group: 04 Building settlements, towns and cities
Themes: 04.01 Planning urban settlements
Sub-Themes:

Nominator's Summary of Significance:

Description:
The Sydney Harbour Bridge includes a steel arch spanning the harbour between Milson's Point on the north side and Dawes Point on the south side, and elevated approaches to the arch from both the north and south sides.

The total length of the bridge, including the approach spans, is 1149 metres. The arch is made up of two 28-panel arch trusses set in vertical planes, 30 metres apart centre to centre, and braced together laterally; it is 57 metres deep beside the pylons and 18 metres deep in the middle of the arch (Godden Mackay, 1992: ref no 0076). It is anchored by two bearings at each end, which take the weight of the bridge and allow for expansion and contraction of the steel. Under maximum load, the thrust is approximately 20,000 tonnes on each bearing (Australian Government, Culture and Recreation Portal).

The span of the arch is 503 metres and the top of the arch is 134 metres above mean sea level. The arch is founded on sandstone rock excavated to a depth of 12 metres and filled with mass concrete. A total of 39,000 tonnes of structural steel was used in the arch, over two-thirds of it silicon steel (Australian Academy of Technological Sciences and Engineering, 2000). Two granite-faced concrete pylons, with a height of 89 metres above mean sea level, are located at each end of the arch (Australian Government, Culture and Recreation Portal).

A deck carrying road and rail traffic is suspended from the arch. Pairs of hangers, ranging in length from 7.3 metres to 58.8 metres, support cross-girders, each weighing 110 tonnes. The cross-girders support the concrete bridge deck (Nicholson, 2000: 26-27). The width of the deck is almost 49 metres and the clearance for shipping is also 49 metres. The deck currently caters for eight lanes of road traffic, two railway tracks, and two pedestrian footways.

The northern and southern approaches each contain five spans, constructed as pairs of parallel-chord, six-panel steel trusses. The spans are supported by pairs of concrete piers faced with granite (Nicholson, 2000: 10-11). The combined length of the approach spans is 646 metres.

Analysis:
CRITERION (a) The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history.

The building of the Sydney Harbour Bridge was a major event in Australia's history, representing a pivotal step in the development of modern Sydney and one of Australia's most important cities. The bridge became a symbol for the aspirations of the nation, a focus for 'optimistic prognostications of a better future' following the Depression. With the construction of the Sydney Harbour Bridge, 'Australia was felt to have truly joined the modern age'. The bridge was significant in fostering a sense of collective national pride in the achievement. It was hailed as an icon of the modern age – an important symbol for the modern city and of modern Australian society. At the time and since, the construction of the bridge represented 'a triumph of the modern age' in Australia, linked to nationalistic aspirations of Australian mateship, faith in 'the ideals of progress in society for the common good', 'a monument to the skill, the labour and the determination of the Australian people'. The bridge, along with the Sydney Opera House, represented an important step in transforming the city of Sydney into a modern metropolis. The Chief Engineer JJC Bradfield saw the bridge as an outstanding engineering feat and transport facility that was integral to the development of Sydney that could become 'the Queen city of the Empire' (Lalor 2005). Internationally, the bridge was recognised as 'a symbol of progress and a vision of the future splendid' like other significant physical and technological achievements of the modern era such as the Statue of Liberty, the Great Wall of China and the Eiffel Tower.

The building of the Sydney Harbour Bridge was an important part of the technical revolution of the 1930s and was seen as evidence of Australia's industrial maturity. The bridge represented the mechanical age displacing the pastoral and agricultural

way of life on which Australia's economy was based and the age of horse and buggy. It signified the era of steel bridges, commuter trains and cars.

The Sydney Harbour Bridge was an important economic and industrial feat in Australia's history and is part of the nationally important story of the development of transport in Australia. The bridge was the most costly engineering achievement in the history of modern Australia and required the demolition of some 800 houses. This was an extraordinary achievement given that it occurred at the severest point of the Depression in Australia. The construction of the Sydney Harbour Bridge marked an important event in the history of Australia's building industry. The scale of the operations was enormous and at the time of its construction, it was the widest long-span bridge in the world.

A large number of people were killed during the building of the bridge (sixteen people from injuries incurred in bridge related workplaces) – this compared to eleven deaths during the building of the famous Golden Gate Bridge in San Francisco, twenty one deaths for the Snowy Mountains Scheme, and thirty five during the construction of the West Gate Bridge, Melbourne.

The Sydney Harbour Bridge continues to be an important national story. It features in documentary programs, is a key event in Australia's history that is taught in schools around Australia and is a significant part of Australian popular culture.

The Sydney Harbour Bridge is an outstanding cultural landmark for the nation and represents a highly significant place in Australia's cultural history. The opening of the Sydney Harbour Bridge was a momentous occasion, drawing remarkable crowds estimated at nearly one million people, when the nation's entire population was only 6.6 million. The ceremony was attended by almost the entire population of Sydney, as well as huge numbers from around New South Wales and thousands from interstate. Francis Edward de Groot, a member of the New Guard disrupted the opening ceremony when, disguised as a military horseman, he slashed the ceremonial ribbon before the Premier was able to officially open the bridge. The incident has become a part of Australian folklore and a symbol of the perceived national character trait of rebellion against authority.

Since its opening in 1932, the Sydney Harbour Bridge has become a famous and enduring national icon and symbol of Australia. The bridge 'remains Australia's most identifiable symbol' – a symbol of something that is quintessentially Australian, 'like kangaroos and koalas' (Nicholson, 2000). The Sydney Harbour Bridge is an important focus of national commemorations, celebrations and other events throughout its history. Some key examples include: the Australian Lancaster Q (for Queenie) flew under the Sydney Harbour Bridge as part of a tour around Australia to raise funds for the war effort in 1943; over a quarter of a million people marched across the bridge in a symbolic apology to Indigenous Australians and the people of the Stolen Generation during the Reconciliation Walk (28 May 2000); Olympic rings were displayed on the bridge during the opening of the Sydney Olympic Games (2000); and the American flag was flown on the bridge in tribute to visiting fire fighters who had been present at the World Trade Centre on September 11, 2001.

The Sydney Harbour Bridge has outstanding value to the nation against Criterion (a).

CRITERION (b) The place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history.

Based on the evidence available, Sydney Harbour Bridge does not have outstanding value to the nation against Criterion (b).

CRITERION (c) The place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history.

Based on the evidence available, Sydney Harbour Bridge does not have outstanding value to the nation against Criterion (c).

CRITERION (d) The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of: a class of Australia's natural or cultural places; or a class of Australia's natural or cultural environments.

Based on the evidence available, Sydney Harbour Bridge does not have outstanding value to the nation against Criterion (i).

CRITERION (e) The place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.

The Chief Engineer JCC Bradfield was committed to a design for the bridge that combined functionality and beauty. He insisted that pylons be added to the original design, largely because they would make the bridge more attractive.

Sydney Harbour Bridge is an integral component of the Sydney Harbour vista and, with the Sydney Opera House, represents one of the most recognisable and iconic images in the world. It is the picturesque blending of the natural environment and man-made structures around the harbour foreshores that is the inspiration for John D Moore's painting *Sydney Harbour* (Prunster, 1982: 18, 60).

The bridge, in its harbour setting, has inspired a rich and diverse range of images in a variety of mediums – paintings, etchings, drawings, linocuts, photographs, film, poems, posters, stained glass - from its construction phase through to the present. It has been the subject for many of Australia's foremost artists, including Sidney Nolan, Grace Cossington Smith, Lloyd Rees, Will Ashton, Margaret Preston, Brett Whiteley and John Olsen (Prunster, 1982: 26-109). In the late 1920s and early 1930s the emerging steel colossus of the modern age that the bridge represented provided inspiration to modernist such as Robert Wakelin, Dorrit Black and Frank Weitzel, while Jessie Traill's etchings of the bridge under construction capture the coming into

being of this colossus. Although international artist Javacheff Christo conceived the idea for a *Wrapped Bridge* in 1969 (Prunster, 1982: 86) it was not realised . In 2005, the National Library of Australia acquired *Harbour Bridges*, by Lola Ryan of the Dharawal/Eora people, of shells and mixed media on cardboard, for its Aboriginal and Torres Strait Islander Art collection (artonview, 2006: 46).

The bridge and the Sydney Opera House are conceivably Australia's most-photographed cultural landmarks, and striking images of the bridge have been captured by some of Australia's best-known photographers, including Max Dupain, Harold Cazneaux, Henri Mallard and David Moore (Prunster, 1982: 26-109). Harold Cazneaux's photographs of the bridge at various stages of construction are in the tradition of Whistler, who romanticised urban or industrial subjects in art with his images of bridges, barges, scaffolding, rigging and boatmen, and of the photographer James Hedderly's photographs of the Thames riverside (Prunster, 1982: 17). Henri Mallard's photography of the Sydney Harbour Bridge captured the workers and their culture.

The Sydney Harbour Bridge has inspired poets and writers, including C J Dennis - *I dips me lid* - Kenneth Slessor and Hugh McRae (Prunster, 1982: 7, 15), and topical songs such as *Bridge of our dreams come true, The bridge we've been waiting for* (National Library of Australia: http://nla.gov.au/nla.mus-an6631851; http://nla.gov.au/nla.mus-an10787298) and *On the day the bridge was opened*.

The Sydney Harbour Bridge has also been replicated in tourist posters, postcards, crafts and the folk arts, its image reproduced in media including glass, ceramic, metal, shells and crochet cotton, embroidery and etchings in a huge array of objects (Prunster, 1982: 110, 120-134).

The Sydney Harbour Bridge has outstanding value to the nation against Criterion (e).

CRITERION (f) The place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.

'Though not quite the longest span, Sydney Harbour Bridge … is undoubtedly the greatest of the world's arch bridges' (Australian Academy of Technological Sciences and Engineering, 2000: 426).

The Sydney Harbour Bridge may be considered the world's greatest arch bridge. Although not the longest arch span in the world, its mass and load capacity are greater than other major arch bridges. Engineers Australia has noted that no other bridge in Australia compares with the Sydney Harbour Bridge in its technical significance. In comparing Sydney Harbour Bridge with overseas arch bridges, Engineers Australia notes its complexity in combining span with width and load carrying capacity (Engineers Australia, 2005: 7).

The project was the greatest labour intensive project to employ nineteenth century work practices of sledge and cold chisel (Jahn, 1997: 123). At the turning of the first sod for the bridge on the North Shore, in July 1923, Bradfield explained that the

bridge would be the heaviest ever built and would set new construction records because its individual members would be the largest ever constructed, lifted or set in place (Lalor, 2005: 93).

At the time of its construction, the Sydney Harbour Bridge was most closely compared with the Bayonne Bridge in New York, completed the year before, and which until 1978 remained the world's longest steel-arch span. The 503-metre arch of the Sydney Harbour Bridge is 0.6 metres shorter than Bayonne. A total of 39,000 tonnes of structural steel was used in the Sydney Harbour Bridge arch, over two-thirds of it silicon steel, with a yield point of 309 MPA (Australian Academy of Technological Sciences and Engineering, 2000: 426). In all 52,800 tonnes were used in the construction of the arch and approach spans, compared with approximately 26,500 tonnes in the Bayonne Bridge.

' … the Sydney Harbour Bridge was the widest-ever long-span bridge, with four rail tracks and six lanes of roadway … The Sydney Harbour Bridge may be considered the world's greatest arch bridge. Although not the longest arch span in the world, its mass and load capacity are greater than other major arch bridges. Engineers Australia has noted that no other bridge in Australia compares with the Sydney Harbour Bridge in its technical significance. In comparing Sydney Harbour Bridge with overseas arch bridges, Engineers Australia notes its complexity in combining span with width and load carrying capacity (Browne, 1996: 39).

The width of the deck of Sydney Harbour Bridge is 49 metres, compared with the Bayonne Bridge which is 26 metres wide and carries four lanes of traffic.

The New River Gorge Bridge in West Virginia, completed in 1977, although 15 metres longer, is less than half the width of the Sydney Harbour Bridge and its mass of steel is significantly less (http://www.nps.gov/neri/bridge.htm). It has since been superseded by the Lupu Bridge in Shanghai, which opened in 2003. The West Gate Bridge across the Yarra River, Melbourne is 2.5 kilometres long with its largest span of 336 metres. The Tasman Bridge, Tasmania opened in 1964 although over 1400 metre in length, its largest viaduct span was 46 metres.

The construction of Sydney Harbour Bridge combined available technology with natural advantages provided by the site. The bridge is an outstanding technical and construction achievement and the designers took advantage of the sandstone base on which Sydney was built - which enabled them to tie back the cables during construction of the arch - to experiment with massive structures. Although designed more than 80 years ago, the bridge has still not reached its loading capacity. A 1987 report from McMillan, Britton & Kell Pty Ltd, Consulting Civil and Structural Engineers, prepared in connection with a proposal to add additional traffic lanes to the bridge, concluded that the bridge had sufficient capacity to carry two additional double-lane decks.
' … the structure is loaded to less than its design capacity … and the estimated maximum live load force at present is less than the design live load force …'
(O'Connor et al, 1987: 3-4).

More than 70 years after opening, the bridge remains structurally unmodified and has still not reached its maximum load capacity. The 1987 bridge development scheme

report concluded that '… it can be expected to continue to serve its original purpose far into the future' (O'Connor et al, 1987: 3).

The Sydney Harbour Bridge has outstanding value to the nation against Criterion (f).

CRITERION (g) The place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.

It was part of JCC Bradfield's vision for the bridge that it be used "at times of national rejoicing". Over the years since its opening it has regularly supported flags, banners, and especially fireworks, becoming a focus for national and local celebrations (Heritage Group, NSW Department of Public Works and Services, 1998: 126).

Community ceremonial and celebratory occasions centred on Sydney Harbour Bridge, either for the people of Sydney or the broad Australian community, are well recognised and have been widely noted.

The bridge has been the centrepiece of events associated with the 1988 Australian Bi-centenary, the Reconciliation Walk in May 2000, the 2000 Sydney Olympics, annual New Year's Eve festivities, National Aids Week and many other social and cultural occasions.

For over forty years the broad Australian community identified the Sydney Harbour Bridge as one of the most nationally and internationally recognised symbol of Australia; since the construction of the Sydney Opera House, it and the bridge in their harbour setting represent a composite symbolic image.

The Sydney Harbour Bridge has outstanding value to the nation against Criterion (g).

CRITERION (h) The place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.

John Job Crew Bradfield ranks with other engineers – including Essington Lewis, Guillaume Delprat and Sir Ian McLennan of BHP, Sir John Coode, Sir Lawrence Wackett, Sir James Kirby, Larry Hartnett, Bill Bradfield, John Watkins, and Sir James Rowland - whose close involvement in a broad range of projects contributed to Australia's national development. Architect Graham Jahn, Fellow and former National President of the Royal Australian Institute of Architects, describes Bradfield as '… one of Australia's greatest civil, structural and transport engineers…' (Jahn, 1997: 123).

As principal design engineer for the New South Wales Public Works Department, J J C Bradfield was largely responsible for finally bringing the Sydney Harbour Bridge to fruition (6). Bradfield had been involved with the bridge proposal since the 1900 competition, in which all of the 24 schemes were rejected (Jahn 1997). In 1912 the New South Wales Government appointed Bradfield Chief Engineer for Metropolitan

Railway Construction and the Sydney Harbour Bridge.

As Chief Engineer, Bradfield prepared the general design and specification and supervised the whole project on behalf of the Government of New South Wales. He also integrated the bridge into the Sydney road, tram and rail system, including construction of an underground railway in the Sydney CBD. He had recommended Dorman Long and Company, the successful tenderers, who retained the services of English consulting engineer Sir Ralph Freeman for the detailed design of the structure.

Bradfield's work and influence extended far beyond Sydney and the Harbour Bridge. He was involved in the construction of the Cataract Dam (the Wollondilly Region of NSW), the first of the great dams for Sydney, completed in 1907, which when built was the largest engineering project ever undertaken in Australia, and the fourth largest of its type in the world. He worked on the design for Burrinjuck Dam, the first major dam built for irrigation in New South Wales. Construction of the dam began in 1907 and water flows commenced in 1912. Bradfield was also responsible for constructing about 500 kilometres of the New South Wales North Coast Railway (Carroll, 1988: 155).

After retiring from the New South Wales Public Service in 1933, Bradfield was appointed consulting engineer for the design and construction of the Story Bridge in Brisbane, which was opened in 1940. He helped to plan and design the University of Queensland at St Lucia, and advocated ambitious schemes to irrigate western Queensland and central Australia. He was technical adviser on construction of the Hornibrook Highway near Brisbane (Spearritt 1970).

Bradfield was nationally recognised through his appointments to the Australian National Research Council and the Australian Commonwealth Standards Advisory Committee. The Institution of Engineers, Australia awarded him the Peter Nicol Russell Medal in 1932, and he also received the Kernot Memorial Medal from the University of Melbourne in 1933, and the Telford Gold Medal from the Institution of Civil Engineers, London in 1934 (Spearritt 1970).

J J C Bradfield was the first Sydney Engineering graduate admitted to the university's Doctorate in Engineering (usyd) and from 1942 he was Deputy Chancellor of the University of Sydney in 1942-43 (Spearritt 1970).

The Sydney Harbour Bridge has outstanding value to the nation against Criterion (h.

CRITERION (i) *The place has outstanding heritage value to the nation because of the place's importance as part of Indigenous traditions.*

Based on the evidence available, Sydney Harbour Bridge does not have outstanding value to the nation against Criterion (i).

History:
Convict architect Francis Greenway proposed a bridge over Sydney Harbour to

Governor Macquarie as early as 1815. In January 1900, tender designs and financial proposals were sought for a bridge to span the harbour. All of the 24 schemes were criticised and thought unsatisfactory. The 1903 design by the firm of J Stewart and Co for a single arch bridge without pylons was rejected as being 'too huge' and 'objectionable' from an artistic point of view (Jahn, 1997: 123).

In 1912, the New South Wales government appointed J J C Bradfield Chief Engineer for Metropolitan Railway Construction and the Sydney Harbour Bridge (Nicholson, 2000: 5). Bradfield submitted preliminary designs for three types of bridge, cantilever, suspension and arch; he favoured cantilever, but after travelling overseas he concluded that an arch bridge would be cheaper (Carroll, 1988: 156). He completed a formal arch design for the bridge in 1916. The bridge was to carry six lanes of road traffic, railway and tram tracks and a footpath on each side. Bradfield's design, involved more than the bridge, which was the key element of an integrated transport system including an extensive network of railways and roadways leading to the bridge, these inturn were integrated into the broader Sydney road, rail and tram system. Known as the Bradfield Scheme, the project also involved the construction of an underground railway in the Sydney CBD. The Bradfield Scheme was a visionary urban transport planning scheme including the world's second underground railway outside of western Europe or North America and the largest single span steel bridge in the world (Lee, 2003: 43).

In 1922 the New South Wales Parliament passed the Sydney Harbour Bridge Act and designs and tenders were invited for a bridge to satisfy Bradfield's broad requirements. The contract was let on 24 March 1924 to Dorman Long & Company of Middlesbrough, England, and included extensive approaches on either side of the arch. While Bradfield was responsible for the concept and the general design, Dorman Long and Company retained the services of English consulting engineer Sir Ralph Freeman for the detailed design of the structure. Dorman Long's tender price, including the distinctive granite pylons, was just under £4¼ million (Australian Academy of Technological Sciences and Engineering, 2000). Bradfield was responsible for overall management of the project and Lawrence Ennis was Director of Construction for the contractors (O'Connor et al, 1987: 11).

Preparatory works for the construction of the bridge approaches were undertaken by the Railways and Public Works Department, and commenced on the North Shore in late 1923, before the tender process was completed (Lalor, 2005:108). These works included the demolition of buildings, mainly houses, in the path of the bridge approaches. Owners of the properties were compensated but not housing tenants (Nicholson, 2000: 6). The concrete piers which were to support the approach spans were completed in September 1926 and the spans in September 1928 (Nicholson, 2000: 11-13).

The arch of the bridge was to be built from both ends, Milson's Point and Dawes Point, and joined in the middle. Each half-arch was built using a creeper crane with a lifting capacity of 122 tonnes, which travelled on the top chords of the arch. The half arches were secured by wire cables, anchored in inclined U-shaped tunnels cut into the rock behind the abutments at each end of the arch (Australian Academy of Technological Sciences and Engineering, 2000). Excavations for the abutments and pylons commenced in January 1925 (Nicholson, 2000: 11).

Most of the steel was manufactured in Dorman, Long's works in Middlesbrough, but the fabrication was carried out on-site in workshops specially constructed for the purpose at Milson's Point (Australian Academy of Technological Sciences and Engineering, 2000). Barges transported the fabricated steelwork from the workshops to points beneath the creeper cranes for lifting up to the arch.

By Christmas 1928, the creeper crane on the southern side was ready to hoist the first steel for the arch into place, commencing with the bearings and pins which transfer the weight of bridge to the foundations. The first panel of the arch was in place by the following March and the creeper crane edged on to the bridge (Nicholson, 2000: 15). The two half-arches were completed in August 1930, and as the steel cables taking their weight were lengthened, the bottom chords were joined on 19 August. The top chord was joined and the arch completed on 9 September 1930.

The temporary wire rope anchorages were then removed and the creeper cranes returned down the arch, erecting the hangers and deck steelwork as they went along. Deck concreting and finishing then followed (Australian Academy of Technological Sciences and Engineering, 2000). In 1931 the road and the two sets of tram and railway tracks were completed, and power and telephone lines and water, gas and drainage pipes were also installed.

The pylons, which serve a mainly aesthetic purpose, are concrete and faced with granite quarried at Moruya on the New South Wales south coast. Dorman Long recruited skilled stonemasons from Scotland and Italy to cut and shape the stone. The first block of stone was laid in October 1925 and the facing was completed by the end of 1931, after the tie-back cables had been removed from the abutments (Nicholson, 2000: 11-14, 28).

Sixteen workers died during construction, of whom seven were employed on the bridge structure itself (City of Sydney, History and Archives). Completion of the bridge in 1932 coincided with the darkest days of the Depression and many of the bridge workers released from their construction tasks swelled the growing ranks of the unemployed. The depth of the Depression in Australia stemmed from the huge debt accumulated during and after World War One. In addition to war borrowings, Australia borrowed vast amounts from Britain during the 1920s, much of it to fund urban development including ambitious works programs. By 1929 Australia owed more to the financial houses of London than all the governments of Europe, Africa, the Far East, Middle East and South America combined (Stone, 2005: 1). The actual cost of constructing the bridge was £6,250,000 which had been borrowed, adding to Australia’s debt.

New South Wales Premier Jack Lang officially opened the Sydney Harbour Bridge on 19 March 1932 amid political controversy. Australia’s perilous debt position had lead to a visit to Australia in August 1930 by Sir Otto Niemeyer, an emissary of the Bank of England to advise Australia’s political leaders as to how the debt position could be best managed. Sir Otto Niemeyer advised that the budget should be balanced using thrift and good management to resolve the debt situation. A view that was in contrast to the newly emerging Keynesian economic model that supported increased public spending to prime the economy during periods of stagflation. Government incomes

were declining due to falling tax revenues and the government's capacity to provide Depression relief would be severely restricted by further tightening its budget.

The Scullin led federal Labor Government took a conservative line and complied with Sir Otto's advice. The impact of pursuing this line worsened the Depression and threw more workers onto the dole. In NSW a change of government in October 1930 saw a Labor Government led by Lang swept to power. Lang championed the worker's cause promising to defy the agreement struck with Sir Otto Niemeyer and default on interest payments to British financial institutions. At the Premier's Conference in February 1931, Lang proposed that Australia not pay any further interest to British bondholders, until Britain dealt with Australian overseas debts in the same manner as she settled her own foreign debts with America. Britain had negotiated concessions from the Americans. Lang's actions divided the political scene including the Labor movement. Tensions rose and conservatives appealed to the Governor of New South Wales, Sir Philip Game to remove Lang.

The period also saw the emergence in New South Wales of the New Guard, a right wing militia organisation styling itself as a citizen's army to assist the police maintain civil order in times of unrest. Funded by the 'establishment' and drawing heavily on the veterans of the First World War, the New Guard saw it's role as defending the peace and keeping subdued any potential uprising by unionists, the unemployed and the working classes all of whom they viewed as communists. Lang with his support for the working classes and his defiance of the establishment's subservience to the financial institutions of Britain was an anathema to the New Guard who viewed him as a danger to Australian society.

Lang's decision, as the elected representative of the people, to preside at the opening of the Sydney Harbour Bridge was controversial in itself as it caused offence to the King who felt such a major occasion warranted royal participation or at the very least, the Governor officiating at the opening. The Governor already under pressure to remove Lang was faced with His Majesty's displeasure. Sir Philip's attempt to persuade the Premier to avoid offence to the monarch and permit him to officiate was unsuccessful. Premier Lang officiated at the opening, however, before he could cut the ribbon to open the bridge, Captain Francis de Groot of the New Guard slashed it with his sword. This New Guard stunt was initiated by the Guard's leadership to thwart more radical action by some of the more extreme Guard members to kidnap Lang prior to the opening of the bridge. The opening of the bridge embodied all the political tensions of the time. This, however, did not stop large numbers of Sydneysiders and interstate visitors flocking to the opening.

The eastern pair of tramway tracks was converted to roadway in 1958 (Godden Mackay, 1992: ref no 0076). A panel which considered a proposal to add two double-lane decks over the outside lanes of the bridge, the railway and Cahill Expressway lanes, handed down its report in March 1987 (O'Connor et al, 1987). The proposal was not implemented, and the alternative of a tunnel under the harbour, which early in the twentieth century Sir John Sulman had suggested was a better option than a bridge (Jahn, 1997: 123), was adopted. The Sydney Harbour Tunnel was completed in August 1992.

Condition:
Changes and modifications have been made to the Sydney Harbour Bridge over the years, mainly to meet the demands of modern traffic.

In 1958 the tram tracks on the eastern side were removed, replaced with two new traffic lanes and connected to the Cahill Expressway over Circular Quay. Other changes include removal of the tram viaduct at the northern approach; extensive reconstruction of the north and south approaches; the construction of the Warringah Expressway between the bridge and Miller Street, North Sydney in the 1960s; installation of toll plazas, overhead gantries and lane indicators, and many signboards; floodlighting of the bridge; and addition of an anti-suicide balustrade. There were also additions to the tops of the bridge pylons (O'Connor et al, 1987: 2-3).

After completion of the bridge, maintenance became, and still is, the responsibility of the New South Wales Government. This responsibility falls principally to the Roads and Traffic Authority of New South Wales, which may involve other bodies, such as the State Rail Authority of New South Wales, as appropriate. Conservation and maintenance policies for the bridge are outlined in the Sydney Harbour Bridge Conservation Management Plan 1998.

The principal consideration is the protection and maintenance of the steelwork by painting. Protection of the steelwork by painting was extremely thorough during the erection of the bridge. A strategy of spot repair and overall repainting has been used continuously ever since the opening of the bridge and it has protected the steelwork remarkably well since then. The environmental and health hazards associated with lead paints now make their use impossible and the task of maintaining the bridge has been made much more difficult due to the lead already on it. A major question is whether to completely remove the old paint and start from bare metal with modern materials. This is a significant issue as there is a limit to the thickness of paint that can be applied to a surface before it starts to fall off under its own weight and due to degradation over time (Sydney Harbour Bridge Conservation Management Plan, 1998: 114).

The Conservation Management Plan outlines other measures to conserve the integrity of the bridge, including that:

- the clarity of the structural form of the original steelwork be maintained
- priority be given to maintenance of the steelwork
- the original form of the granite-clad pylons and piers be maintained
- the fabric of the rendered masonry approach structures not be obscured or damaged
- the arrangement of internal spaces in the abutments, pylons and approach structures be conserved
- the visual form and setting of the bridge not be obscured by buildings or large plantings on the harbour foreshore
- views and vistas be maintained
- commercial advertising on the bridge be excluded (Sydney Harbour Bridge Conservation Management Plan, 1998: 126-137).

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