= Narrows Bridge (Perth) =

The Narrows Bridge is a freeway crossing of the Swan River in Perth , Western Australia .

Made up of two road bridges and a railway bridge located over a section of water known as The Narrows , located between Mill Point and Point Lewis , it connects the Mitchell and Kwinana Freeways , linking the city 's northern and southern suburbs . The original road bridge was opened in 1959 and was the largest precast prestressed concrete bridge in the world . Construction of the northern interchange for this bridge necessitated the reclamation of a large amount of land from the river .

The bridge formed part of the Kwinana Freeway which originally ran for only 2 @.@ 4 miles (3 @.@ 9 km) . Over the following decades , the freeway system was expanded to the north and south , greatly increasing the volume of traffic using the bridge . As a result , in 2001 , a duplicate traffic bridge was opened to the west of the original bridge , and in 2005 , the railway bridge was constructed in the gap between the two traffic bridges . Passenger trains first traversed the Narrows in 2007 with the opening of the Mandurah railway line .

= = First road bridge : 1959 = =

The close distance between Mill Point and Point Lewis at the foot of Mount Eliza meant the site was suggested as a suitable location for a bridge as early as 1849 . A bridge was proposed for the site in 1899 , but its expected cost of £ 13 @,@ 000 was deemed too high . Preliminary planning for a bridge at the site finally began in 1947 , but was suspended so that a replacement , The Causeway , could be built at Heirisson Island , at the city 's eastern end . The new Causeway bridges were opened in 1952 , and by 1954 traffic using them to enter the city had doubled , renewing calls for a bridge at The Narrows .

Site investigations for the bridge began in August 1954 . The bridge was proposed for The Narrows site by the Town Planning Commission under the chairmanship of Harold Boas . The chosen site drew public protest on the basis that the bridge would spoil the view to and from the city . Also , residents of the wealthy Mill Point area were angry that they would have a major highway running beside their houses . The site also necessitated the reclamation of 60 acres (24 ha) of land from Mounts Bay for the bridge approach and interchange . This land reclamation , which started in October 1954 , saw the addition of 4 @,@ 500 @,@ 000 cubic yards (3 @,@ 400 @,@ 000 m3) of sand , much of which was dredged from Melville Water .

The State started saving for the new bridge in September 1954 , and the construction of the bridge was approved by the Hawke state Labor government in November 1954 , before the Hepburn @-@ Stephenson metropolitan roads plan had been finalised , such was the urgency of a new traffic link . The construction of the bridge was subsequently endorsed in the 1955 Hepburn ? Stephenson plan , which later developed into the Metropolitan Region Scheme .

The river bed at the site of the proposed bridge was not ideal for bridge building , with soft mud extending down up to 80 feet (24 m) , with sand beds below that going a further 40 feet (12 m) down . Ernie Godfrey , a bridge engineer with the Main Roads Department , travelled overseas to inspect bridges in similar geological locations and to source a designer for the proposed bridge . The design contract for the bridge was won by British engineering firm Maunsell & Co .

Construction on the road system began in 1956 , and the contract for construction of the bridge was signed by Commissioner of Main Roads J. Digby Leach on 16 March 1957 . The bridge was built by Danish firm Christiani and Nielsen in conjunction with Western Australian engineering firm J. O. Clough & Son . Leif Ott Nilsen oversaw construction on behalf of Christiani and Nielsen . The first timber pile for the temporary staging for the construction was driven at noon on 8 June 1957 . The first permanent pile for the bridge was driven home on 18 August 1957 . Work on the bridge 's precast concrete beams began in September 1957 , and the first of these was lifted into place by the 60 @-@ foot (18 m) gantry crane in February 1958 . The last river pile was driven home in November 1958 , and the final concrete beam was lowered into position in June 1959 .

During construction on 10 February 1959 , John Tonkin , then the Deputy Premier and Minister for

Works , announced that the new bridge was to be named the Golden West Bridge . However , Golden West was also the name for a popular soft drink ; the proposal encountered scorn from commentators and was quietly dropped .

The bridge cost £ 1 @.@ 5 million , as part of a wider road system costing £ 3 @.@ 5 million . Construction on the bridge took 2 years and 5 months . It was officially opened by Governor Charles Gairdner on 13 November 1959 . He unveiled a plaque on the bridge together with Premier Sir David Brand , Commissioner of Main Roads J. Digby Leach and Works Minister Wild . Gairdner was also the first person to drive across the new bridge . It was hoped at this stage that the debt raised to pay for the bridge would be repaid by the Government within 12 months .

The bridge formed part of the new Kwinana Freeway , which originally ran 2 @.@ 4 miles (3 @.@ 9 km) from the Narrows to Canning Highway . This was described as the " most modern highway " in Western Australia , with a speed limit of 50 miles per hour (80 km / h) . The bridge was also the largest precast prestressed concrete bridge in the world at the time of its opening .

= = = Design = = =

The bridge was jointly designed by engineering firm G. Maunsell & Partners and architects William Halford & Partners . The prestressed concrete design was relatively new for Western Australia , where road bridges had traditionally been built from timber frameworks . The bridge is arched along its length , with a vertical curve of up to 4 % grade .

The unusually soft soil conditions at the site forced the use 160 " Gambia piles " for the bridge 's foundations , named after the country in which they were first used . The 31 @-@ inch (79 cm) diameter piles have steel shells and conical noses . The hollow piles were driven by a drop hammer falling within them , then when they had sufficient resistance to driving , they were filled with reinforced concrete .

The piles support two river piers , two shore piers and two abutments . The bridge 's support columns on the piers were designed in a triangular form , larger at the top than at the bottom , each carrying two of the bridge 's beams , so as to not completely obstruct the view through the bridge 's piers . These columns support the bridge 's five spans : a central span of 320 feet (98 m) , two flanking spans of 230 feet (70 m) each and two smaller spans of 160 feet (49 m) at each end passing over roadways . The bridge has eight parallel lines of beams . Each line of beams consists of two cantilever spans 370 feet (110 m) long suspended between the shore and river piers , a central suspended span 140 feet (43 m) long between the two river piers , and two 110 @-@ foot (34 m) spans suspended over roadways at either end . Suspended between the beams of the bridge were 1 mile (1 @.@ 6 km) of 30 @-@ inch (76 cm) water mains pipes and 0 @.@ 5 miles (800 m) of 10 @.@ 5 @-@ inch (27 cm) gas and drainage pipes .

Footpaths 8 feet (2 @.@ 4 m) wide on either side of the bridge were formed by concrete cast in situ and cantilevered out from the adjacent beams . These footpaths were separated from the roadway and the bridge 's edge by lightweight aluminium balustrades and safety fences installed by Bristile . The street lights were integrated into the safety fence .

The deck of the bridge was formed by pre @-@ casting individual concrete units on the southern river shore , then hoisting them into place on temporary timber staging in the river . The units were then structurally joined by strands of high @-@ tensile wire and stretched with a hydraulic jack . These pre @-@ stressing strands were anchored in reinforced concrete blocks at the ends of the spans . The new bridge had a traffic capacity of 6 @,@ 000 cars per hour in each direction , over a total of six traffic lanes .

= = = Post @-@ completion history = = =

Strengthening works were carried out on the bridge by Structural Systems Ltd in 1996 . Also in 1996 , decorative night lighting was installed on each side of the bridge . The bridge was entered on the state 's heritage register on 8 January 1999 , and was named a national engineering landmark by the Institution of Engineers , Australia , in November 1999 .

The opening of the southern regions of Perth to easier central business district access changed the nature of the metropolitan area , prompting dramatic population growth south of the river . This led to increased traffic on the bridge , causing regular traffic jams in peak hour . Over the years , governments suggested various ideas to reduce the traffic using the bridge , including introducing congestion pricing similar to that used in Singapore , charging vehicles to enter the central business district during peak periods . The government also encouraged voluntary car sharing . These efforts were largely unsuccessful , and by the 1990s , the bridge had become the city 's worst traffic bottleneck , despite the addition of an extra traffic lane , bringing the total number of lanes to seven .

= = Second road bridge : 2001 = =

Plans for a second Narrows Bridge were mooted during the 1970s , but did not eventuate . By 1998 , the original bridge was carrying 155 @,@ 000 vehicles per day , with an average of 2 @,@ 700 cars per lane between 7 : 30 am and 8 : 30 am , and was thought to be the busiest section of freeway in the country . This quantity of traffic far outstripped the expected capacity of the bridge when it opened in 1959 . The solution to the traffic problem most favoured by road planners in 1998 was to widen the existing bridge by building a smaller second traffic bridge just west from it and joining their decks to form a contiguous roadway . This would increase the number of traffic lanes from seven to 10 . The widening was expected to cost $ 50 million .

A plan to widen the Narrows Bridge was announced on 13 April 1998 by the Court Liberal State Government . The $ 70 million plan would involve the addition of four extra traffic lanes , and was part of a $ 230 million package upgrading and extending the southern end of the Kwinana Freeway . Alannah McTiernan , then the Opposition Transport spokesperson , attacked the plan , saying that the government should instead build a railway to Rockingham .

Instead of widening the existing structure , Transport Minister Eric Charlton on 15 July 1998 approved the construction of a separate second road bridge alongside the original Narrows Bridge ; this solution would cost $ 15 million less , due to new building techniques , and would be less disruptive to traffic on the existing bridge . The construction of a separate bridge was also deemed necessary because the foundations of any new structure might settle in the soft river bed at a different rate to the existing bridge . Under the plan , there would be six lanes on each bridge , including a bus lane on each . The new bridge would run parallel to the original bridge and be separated from it by a gap of 6 metres (20 ft) , and was designed to look largely the same as the original .

Main Roads called for tenders for the bridge widening in July 1998 , and on 7 March 1999 it was announced that the building contract had been awarded to Leighton Contractors . The negotiated contract price was reduced to $ 49 million owing to the construction method proposed by Leighton . The designers were Connell Wagner .

The bridge was constructed by the incremental launching technique , with 28 @-@ metre (92 ft) segments pre @-@ cast on both shores and pushed out into place as the construction progressed . The bridge was divided into two strips lengthways , with the eastern half launched separately from the western half , and the two decks were later joined at the bridge 's centre line . The first of twelve segments was launched in February 2000 .

As it was being launched , the bridge rested on temporary piles ; only after the structure was fully launched were these piles removed and the bridge allowed to rest on its permanent supports . The construction required the driving of around 250 steel piles ; the first was driven on 10 August 1999 .

Construction of the second bridge was interrupted several times by strikes , as well as by an algal bloom in the Swan River . The bridge was finally opened to traffic on 26 February 2001 , and officially opened by new Transport Minister Alannah McTiernan (a strident critic of the project) on 30 May 2001 . The bridge had originally been planned to be opened in August 2000 , and was expected to carry 80 @,@ 000 cars per day . The new traffic bridge carried six lanes of traffic , including one bus lane , and the original bridge was modified at this time to carry six traffic lanes , as designed .

= = Railway bridge : 2005 = =

During the construction of the second road bridge , the construction of a railway through Perth 's southern suburbs to Rockingham and Mandurah became a political issue . The incumbent Liberal State Government proposed building a railway from Kenwick to connect to the Kwinana Freeway , running in the centre of the freeway for only part of its journey . The Labor opposition instead wanted to build the railway across the Narrows Bridge and down most of the length of the freeway .

After the Labor party won the 2001 state election , they reversed the previous government 's position and started planning for the installation of railway tracks across the Narrows Bridge . The construction of a third bridge was needed due to the lack of previous planning provisions when the second bridge was constructed . Leighton Constructions won the contract to build the freeway stage of the railway line and set about constructing a narrow southbound railway bridge in the 6 @-@ metre (20 ft) gap between the existing road bridges . The designers of " Package E " of the Southern Suburbs Railway (which included the Narrows Rail Bridge) were GHD , Coffey Geosciences and Wyche Consulting . The eastern side of the existing northbound (2001) bridge was also strengthened to accommodate the northbound railway track . Construction was due to start in July 2005 and completion was expected by December 2005 . The first passengers traversed the Narrows on 23 December 2007 with the opening of the Mandurah Railway Line .

The railway bridge deck was made from nine steel girders each weighing up to 99 @.@ 5 tonnes (219 @,@ 000 lb) and up to 54 metres (177 ft) long . These girders were built in Kwinana , brought to the site by road and lowered into position with a crane .