Three New Zealand Engineers in Colonial Victoria - Brees, Holmes, and Richardson.

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Abstract
In early 1853 in Victoria, Australia, three engineers: Samuel Charles Brees (1810–1865), George Holmes (*circa* 1822–1877) and Edward Richardson (*circa* 1831–1915) came together in the design and construction of "Brees Bridge," a large Howe through-truss timber road bridge over the Maribyrnong River at Keilor. These engineers are well known in New Zealand: Brees as engineer/surveyor/artist for the New Zealand Company 1842–1845 and Holmes and Richardson as the contractors for the very significant Christchurch to Lyttelton Railway line and tunnel, 1861–1867. But their engineering work in Victoria is not well known. In 1853, Brees was briefly the first Colonial Engineer, and between 1853 and 1861, Holmes and Richardson were the contractors for many significant engineering works in Victoria: the first large laminated timber arch bridge (Johnston Street); the first large iron box girder railway bridge (Maribyrnong River); and other works (Yarra River Wharves, South Yarra Waterworks, Essendon Railway, and Brighton Railway). This paper explores the interrelationships between these engineers and their contemporaries, describes their significant engineering works, and fills some biographical gaps about their lives in Victoria.

1. Introduction - Colonial Victoria 1851–1861

To understand the contributions that engineers Samuel Charles Brees (1810–1865), George Holmes (*circa* 1822–1877) and Edward Richardson (*circa* 1831–1915) made to Victoria, Australia, we need to have an understanding of the changing social, economic and political environment of early colonial Victoria.

Before the gold rushes, and separation of the "Port Phillip District" from New South Wales (NSW) in 1851, progress on building 'permanent' roads and bridges was slow and lengthy, with long administrative approval processes going backwards and forwards from Melbourne, through Sydney, and to London. As soon as the gold rushes commenced in Victoria, roads and bridges to service the rapidly rising population, and the shifting goldfields, were urgently needed. The existing arrangements failed. New administrative and contractual arrangements were necessary for the new Colony.

Following major floods in 1852, and a Victorian Parliamentary Select Committee on *"Roads and Bridges"*, a Central Road Board was established for main roads, and separate District Road Boards were established for parish or cross roads. To expedite construction, many concurrent separate contracts were let for sections of the same main roads, which meant many inspectors and administrators to supervise the arrangements. It wasn't too long before tolls were imposed, and later the responsibilities for main roads and bridges were delegated to the District Road Boards, to decentralise the administration further. However, government funds were still needed for major works, so a well skilled centralised overview administration was required. These processes were again fraught with problems and further reviews were needed. The 1854 Parliamentary Commission on *"Internal Communication of the Colony"* gathered evidence and made recommendations that helped set in place necessary changed administrative and legislative frameworks and processes.

As the colony developed, and society's needs changed, other works such as water supply, gasworks and railways were also needed and similar delegated and centralised administrative processes were established.

Private companies were able to raise funds for projects, provided they could get government approval and a supporting Act of Parliament. Many private railway and waterworks companies were floated, but raising funds for large projects, such as the major trunk railway lines needed for the colony, was difficult if not impossible.

The financial collapse in England and Europe, that had followed the railway boom, meant that only governments could secure funding for large projects. The 1857 Parliamentary Select Committee on *"Railways …"* recommended that the colonial government take over the role for main trunk lines of railway (Melbourne to Mount Alexander, Melbourne to Geelong, Geelong to Ballarat), leaving secondary lines, such as suburban private railway companies to fend for

themselves. To expedite main line railway development, the staff from the former companies moved to the department, and many concurrent separate contracts were then let for sections of work on the same main railway routes. This meant, many inspectors and administrators to supervise the arrangements, and again these processes were fraught with problems, leading to the 1860 Parliamentary Select Committee on the *"Railways Department."*

More major floods in 1861 and 1863 again caused major damage to infrastructure and further demands and strains on Government funds and administrative processes, leading to another cycle of reviews and changes. By then our three engineers had left Victoria.

As we examine the key engineering works associated with these engineers, we will delve deeper to see the roles they played in these events, and the influence of them on their lives.

2. Samuel Charles Brees, Colonial Engineer

On 25 January 1853, Brees was appointed to be the first (acting) Colonial Engineer for the Colony of Victoria [1] by William Lonsdale (1799–1864) [2], acting Lieutenant Governor of Victoria.

Brees had landed in Melbourne on 2 September 1852, with his family, having emigrated on the first voyage of the steam-ship *"Australian"*. [3] [4]

Brees was described as *"late of the London and Birmingham Railway, Principal Engineer of the New Zealand Company, Executive Engineer of the East India Railway, &c."* [5] and the author of many *"Engineering Books"* and *"Illustrations of New Zealand*"**.**

Brees was born in Bloomsbury, Middlesex, England 29 May 1810, [6] the son of Samuel Brees and Susanna James. [7] He was probably trained as an engineer, surveyor and architect in London where he submitted a design for a village church that won a gold medallion from the *Society of Arts* in 1830. [8] He married Ann Taylor Jones on 25 June 1833, at St. John of Jerusalem Church, in South Hackney London. [9] From 1832 to 1837 he exhibited topographical drawings at the Royal Academy and he entered the competition for the design of the Houses of Parliament 1835.

In England, Brees is best known as an author of early railway engineering books. In 1837 *"Railway Practice: a collection of working plans and practical details of construction in the public works of the most celebrated engineers ..."* was published by John Williams. [10] This book included specifications and details about the works of Vignoles, Landmann, Brunel, Walker, Macneill, and Stephenson, and the London & Birmingham Railway that was nearing completion. It was a *"compilation that would serve as an exemplar for aspiring railway engineers."*

This book also included Samuel's artwork *"View of North Church Tunnel, London & Birmingham Railway"* as its frontispiece, an original of which is in the State Library of Victoria. [11]

In 1838, a second edition of *"Railway Practice …"* with corrections and additions was published, [12] followed in 1839 by an *"Appendix"* [13] that included evidence on the Birmingham & London and Greater Western Railways, and an illustrated glossary of engineering terms. In 1840, a third edition of *"Railway Practice ..."* was published [14] followed in 1841 by a separate *"Glossary of Civil Engineering…".* [15] Brees also self-published a series of architectural drawings *"The Portfolio of Rural Architecture…".* [16]

In the 1841 Census, he was a Civil Engineer, aged about 30, living in St.Pancras with his wife Ann, also about 30, and two sons, Harold and Alfred (aged 3 and 1 respectively). [17]

For three years, from 1842, Brees was in New Zealand with his family, as the principal surveyor and civil engineer, working for the New Zealand Company, and for Colonel William Hayward Wakefield (1801–1848). Brees's life and work in New Zealand is generally well documented in New Zealand biographies. [18] [19] Among other work, he was responsible for the first land surveys for the Port Nicholson conveyance, including working closely with the Maoris in surveying the land and 'reserves for the natives'. [20] [21]

In 1845, Brees is listed as the Engineer-in-Chief in the £1,200,000 prospectus for "The Oxford and Salisbury Direct Railway", [22] as well as working as a surveyor and architect, [23] and working for the New Zealand Company in England. [24]

Following his period in New Zealand he published *"Pictorial illustrations of New Zealand,"* in 1847, [25] a *"Map of New Zealand, the Island of New Ulster and the several harbours …"* [26] and *"…the Panorama of New Zealand…"* 1849 [27] all by *"the late Principal Engineer and Surveyor to the New Zealand Company".* The *"Panorama.."* also became a major painted exhibition at No.6 Leicester Square, promoting both New Zealand and Brees.

Brees's role as the *"Executive Engineer of the East India Railway Company"* still needs more research.

In 1847 another edition of *"Railway Practice"* was published; a second edition of *"Appendix"* and a fourth series of *"Railway Practice"* was published - the latter including French Railways. It was common practice at the time to republish European texts in English - such as those by John Weale,

and Robert Scott Burn. By now Brees's *"Railway Practice"* was a series of four volumes. [28]

It appears that in 1846 Brees also produced *"An Introduction to the present practice of Surveying and Levelling ..."* [29] and in 1849 *"The Student's Guide to the Locomotive Engine ... ".* [30]

An enlarged edition of his 'glossary' was published in 1852 as "*Illustrated Glossary of Civil Engineering …"* [31] and republished in 1853. [32]

In 1851, Samuel Charles Brees, aged 40, is listed as a Surveyor, living in Glebe Lands, Mitcham, Surrey, with his wife Ann Taylor Brees, aged 39, and children: Harold 13 (born Holborn), Alfred 11 (b. Finchley), Edgar 9 (b. St.Pancras), Alice 7 (b. New Zealand), and Emma aged 2 (b. Mitcham). [33] A son Oswald was born in 1851 in Croydon, [34] but died in Brighton, Victoria, aged 15 months. [35]

In 1851, Brees published *"A Key to the Colonies, or, Advice to the Million on Emigration …"* [36] This 104 page pamphlet includes: a Dec 1849 review by *"The Times"* of his exhibition 'Panorama of New Zealand'; many personal 1841 'testimonials' from eminent engineers (Stephenson, Locke, Macneill, Buck, Landmann, Twynam, Cressy, Kendall); and a list of all his books. How this egocentric work was received in England or in Victoria is not known, but its contents appears to have put some colonies 'off-side'. So when he arrived in goldrush Victoria in September 1852, Brees was an 'open book'.

From 1836 until Victoria gained separation from NSW in 1851, it was governed from Sydney. For most of this period, from 1838 to 1846, the Governor was Sir George Gipps R.E. (1791–1847). [37] In September 1839, Charles Joseph La Trobe (1801–1875) [38] arrived in Melbourne and took up the new position as the Superintendent of the Port Phillip District, reporting to Gipps, who in turn reported to London.

In October 1844, David Lennox (1788–1873), [39] who had been the Superintendent of Bridges in NSW since 1832, was despatched to Melbourne to erect Princes Bridge over the Yarra River. (Figure 1) This bluestone and granite bridge, with a 150 feet central arch, a low rise of 24 feet, and with a total bridge length of 250 feet [40] completed in 1851, was built under his sole supervision, and was equal to any single-arch stone bridge in Great Britain. As Lennox later described it, for £19,000 it cost *"less than any work of a similar description in the Mother Country, as an instance of which I may adduce the expenditure of Gloucester Bridge (which is of a like nature to the one under notice), namely, £43,500".* [41] Lennox's role had quickly expanded to encompass being the superintendent of Roads, Bridges, Wharves, and Jetties, across the whole district of "Port Phillip".

Victoria formally separated from NSW on 1 July 1851, La Trobe became Lieutenant Governor of the Colony, and very soon afterwards gold was 'discovered', and the gold rushes began.

Figure 1: Opening of Princes Bridge, 15 Nov 1851. Commemorating the arrival of Separation. [42]

The enormous influx of immigrants that followed the gold, strained all the infant colony's resources and infrastructure.

Victoria may have gained separation, but the progress towards a representative government, a constitution and self-government was not swift. Initially, only substantial property holders elected 20 of the 30 members of the Legislative Council, and the Lieutenant Governor the rest, with the Governor in NSW appointing Victoria's Ministers.

In March 1852, *"The Argus"* editorial was predicting *'Starvation at the Diggings'* describing the poor conditions of the main road and bridges between Melbourne and the Mount Alexander goldfields and foreboding the dire prospects of feeding and servicing the 40,000 diggers there during winter, concluding that: *"From the first discovery of the gold-fields our incessant cry has been 'police, police, police;' we still say 'police', but we also say 'bridges and roads, bridges and roads, bridges and roads'".* [43]

Almost on cue, the long drought broke in May 1852 with an unprecedented storm lasting two days, flooding settlements, drowning many, and destroying bridges and roads across the whole Colony. [44] [45] The cost of moving goods from Melbourne to the goldfields rose to an extraordinary rate of £90 per ton! [46]

The November 1852 Victorian Legislative Council Select Committee on *"Roads and Bridges",* [47] dominated by rural M.L.C.s, was critical of the state of affairs and the administrative arrangements. The Committee noted that:

"About seventy Timber Bridges have … been erected in the Interior, at a cost varying … from £15 to £1500. : Many … have been swept away,

and those that remain are almost all of so faulty a construction, … to render it more than probable that they will share the same fate, when washed by floods at all beyond the ordinary height. And … as many as seventy additional Bridges are now urgently required for dangerous crossing places in the Interior. It appears … that the chief cause of the insufficient number and imperfect construction of these Timber Bridges may be found in the smallness of the sums voted for the construction of these indispensable Public Works".

They were also critical of bridges with piled piers that had been damaged or washed away when logs had built up against the piers during floods.

They also noted that from Returns on the table of the House, from the formation of the Colony in 1848 to 30 June 1851, £36,655-5-9 had been expended on Roads, Streets and Buildings, of which nearly £20,000 was expended in Melbourne on Prince's Bridge. [48]

The Select Committee recommended a Central Road Board with a system of independently established decentralised District Road Boards, and that all roads and bridges should be tolled.

By now Lennox must have been feeling the criticism and the enormously increased work load. He retired in 1853, aged 66. Having served for more than 21 years in his role as Superintendent of Roads and Bridges, he was entitled to a pension, and sought and was granted a gratuity of £3,000 for his extra services in Victoria. In 1853, Robert Hoddle (1794–1881), the Surveyor General, also retired (or was eased out), and Captain Andrew Clarke R.E. (1824–1902) [49] took over the position.

Brees's 'acting' appointment in 1853 appears to have been a 'stop-gap' between the resignation of Lennox, Superintendent of Roads and Bridges, and the arrival of a person with broader management skills to take up and service the rapidly expanding duties and role of Colonial Engineer.

Brees's successor, Captain Charles Pasley R.E. (1824–1890), [50] a military college contemporary of Captain Andrew Clarke R.E., was appointed in England on April 1853, and would arrive and take up his position as Colonial Engineer on 20 September 1853. [51]

The parlous state of affairs in Victoria is easily seen in Brees's *"Statement of money expended from various votes for public works from 1st January to 31st December 1852"* [52] (the period before Brees was in office) presented to Parliament in August 1853. Less than half the £20,000 voted for Roads, Bridges, and other works had been expended, and most of the spending priorities were on access tracks to the goldfields. Labour and materials had become expensive and hard to procure.

Brees may or may not have had the necessary skills to handle the enormous task, but either way, he had landed himself in a 'no win' situation.

3. Brees Bridge 1853

Figure 2: 'Keilor Bridge' Watercolour of 'Brees Bridge' by Samuel Charles Brees. [53]

Nevertheless, during his very brief time as acting Colonial Engineer, Brees did achieve some things, notably 'Brees Bridge' over the Saltwater River (Maribyrnong River) at Keilor. (Figure 2) This was a most impressive pioneering bridge with high stone abutments, in a gorge setting, with steep winding approaches, on the main road from Melbourne to the Mount Alexander goldfields. The *"river rises here in floods to thirty feet or more above the bed of the river"*, and *"the traffic on the road exceeded that of any road in England, and yet no provision was made for a crossing, several old structures being washed away."*

Apart from Lennox's stone arch 'Princes Bridge', all other bridges in the colony had been constructed in timber. The longest being the many span timber bridge over the Barwon River on the road from Geelong to Port Fairy, with a total waterway crossing of 190 feet. [54] [55]

The 'Brees Bridge' comprised three large 'Howe' patent through-trusses 160 feet long, and 17 feet high, with a clear span of 135 feet, on 38 feet high stone abutments *"the outside courses being hammered and dressed, and the hearting of rubble masonry".* The superstructure of the bridge consisting of two 10 feet 6 inch carriageways between the trusses, on a deck supported on the truss bottom chords. The contract for the "Mount Alexander Road, Keilor Bridge", Stone Abutments and 160 ft Howe Truss was awarded to Thomas Oldham and others, for £11,383-0-0 in March 1853 with a December 1853 completion. Unfortunately Oldham became insolvent and the erection was completed by the Central Road Board, with George Holmes C.E. Engineer being paid £400. [56] The works were finally completed in

April 1854, with the total cost of the whole crossing being about £20,000.

Holmes had been working for the Central Road Board, in February 1854, when he was paid by Treasury for house rent, so it appears that he was still working for them when he took charge of completing the Keilor Bridge. [57]

The manner of construction of the bridge is described in a paper *"The Keilor Bridge"* presented on 7 June 1855, by Richardson, also an engineer for the Central Road Board, to the Victorian Institute for the Advancement of Science (VIAS), then in its first year. VIAS later merged with the Philosophical Institute of Victoria, and became the Royal Society of Victoria. [58] [59]

"At the time … there were only two contractors in Melbourne considered competent to undertake the work, one of these being the successful tenderer…" [Oldham] *"… being a gentleman of great practical attainments, undertook to build the trusses according to his views, although repeatedly advised by the engineer* [Holmes] *to the contrary."*

Oldham was a very experienced railway contractor prior to arriving in the colonies, but seemed unable to adapt easily to the colonial conditions, or to new ideas.

"When the work was commenced, the only suitable timber that could be obtained was four large pine logs; the material had been collected from all sources, chiefly from New Zealand." And in discussion, Richardson noted that *"Kaurie [sic] pine had the same property as English oak of shrinking whenever it was cut, even although it had been previously seasoned."*

The trusses were first framed on the ground, then set on edge, then rotated 60 degrees to align then with the axis of the bridge, then launched across the abutments on edge. *"This was an undertaking of no small mechanical skill, and is worthy of the man who projected the plan. A truss of 17 feet high, 50 tons weight, and 160 feet long, to be moved across a chasm 100 feet, even with English means, would be considered no mean undertaking".* The first truss was successfully launched with no problems, but an accident occurred after the second truss had been raised on edge, and was being launched, the balance was lost and that portion of the structure fell to pieces. Five men were under the truss when it fell, but fortunately they escaped by passing through the apertures.

"The case being one of great difficulty the Government allowed the contractor to proceed with the work until this truss was rebuilt and carried over, on the condition that the resident engineer [Richardson] *was responsible for the completion of the work. This being the first time the engineer was allowed to interfere with the arrangements or mode of carrying on the works."*
"… the engineer, Mr. George Holmes, previously expressed his dissatisfaction as to the plans proposed for erecting the bridge, his own notion being to erect a temporary pile scaffolding, and on that to erect the truss, but … taking the position of the broken truss, it was thought advisable to conform to the contractor's views and assist him - … the second truss was launched safely and placed in its position without incident."

Richardson noted that *"… particular attention to details is often of more importance in the stability of a structure…"* and *"as an instance, a design by the engineer* [Holmes], *of a clamp … proved its efficacy in the broken truss, the truss was broken in three places, but in no instance where a joining of beams took place did the clamp give way".*

The third truss was, by Richardson's instructions, *"built on a platform resting on the two trusses previously carried across, and in one third the time and expense taken to place either of the others in its position, which evidently proves the suggestion of the engineer in the first instance, that is, to build the bridge on a platform".*

During discussion, Thomas Ellis Rawlinson C.E. (1823–1882) noted that a similar accident to that with the truss as Keilor, had previously occurred in Liverpool, England.

The 'Brees Bridge' appears to be the first large 'Howe' truss bridge to be built in Australia. Howe patent trusses (Figure 3) were the first 'composite' trusses, modified from 'Long' trusses, with vertical iron rods used between the top and bottom chords, instead of timber. [60] At Keilor, the end bays at each end appear to have had timber verticals, to strengthen and stiffen the truss at the abutments.

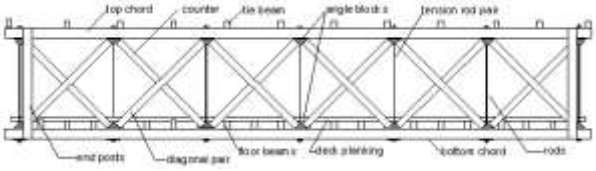

Figure 3 Diagram of Howe Truss. [61]

Richardson stated that the quality of the workmanship would compare well against similar constructions in Europe and America, and suggested that *"if this bridge were enclosed and weather-boarded, it would last thirty years".*

The mutual respect established between Holmes and Richardson, when working together on 'Brees Bridge', set the foundations for their enduring 23 year partnership.

Within a few months of the completion of the bridge, the Act was passed that enabled District Road Boards and the Central Road Board to collect tolls on bridges. So a toll house was built for the Keilor Bridge.

Although the bridge served the gold rush traffic well, the huge volume of traffic and the climate also took its toll on the bridge. Pine timber exposed to Australia's weather rapidly deteriorates, through moisture, rot, fungus, or insects - droughts and flooding rains accelerates the decline.

The terrible floods in 1861 and 1863, damaged or destroyed many bridges. The damaged ones were 'temporarily' stabilised, repaired or strengthened with timber props or struts. Ironically, in 1863 the full responsibility for bridges and tolls had been transferred to the District Road Boards. After the floods they all had difficulty, and sought funds from government for repairs or replacement.

By 1865, the notable, and accurate, colonial artist Eugene von Guerard sketched the Keilor bridge. [62] His sketches show that the bridge trusses had been: propped by a central pier; propped on the left bank by many short diagonal struts and the left masonry abutment was covered in earth to combat erosion; propped with a few diagonal struts from the right masonry abutment; and some weather protection in the form of small roofs had been added over the tops of the three trusses. The newspapers in 1866 confirm the sad state of the bridge depicted in von Guerard's sketch – half of the bridge was closed, and it needed major maintenance work or replacing. [63]

A temporary replacement bridge was built in early 1867, and on 21 November 1868, a new 'tubular' iron bridge, built for the Keilor District Road Board, was opened, replacing the timber Howe trusses. Newspapers provide very detailed descriptions of the bridge, and the opening festivities. [64] The new bridge was also a through bridge. The wrought-iron box girders were 142 feet long, spanned 136 ft between the old bluestone abutments, that were raised 3 ft 11 in, with one roadway 20 ft wide and 45 ft above the summer river level, 6 ft 6 in above the flood levels. The old abutments were in poor condition, the one *"on the left bank had to be taken down altogether, and an entirely new one erected in its place. The one on the right bank of the river had also to be taken down to the depth of six feet",* meaning only the top 6 feet. The stones from the condemned left bank abutment were used to protect the new abutment from erosion. [65] The engineer for the new bridge work was Edwin Brown (1812–1879) and Son, Camberwell, and the contractor was Enoch Chambers, the whole work costing £6,000. The bridge became known locally as the "Basket Bridge" because of its mid-span handle-like upper-chord lateral-bracing.

The bridge deck was repaired in 1926, the curved 'handle' bracing was replaced with a squared steel brace in the 1950s, and the bridge was taken out of service in 1964 when a replacement bridge on a new alignment was opened. [66]

Today the 1868 box iron girder bridge, still stands on the repaired 1853 bluestone abutments, and is used as a pedestrian bridge in the Maribyrnong valley parklands. It is of state significance, is included on the Victorian Heritage Register, [67] and is technically significant for the structure of its box girders that have two smaller boxes or cells forming the tops of the girders. [68]

4. Samuel Charles Brees – after 1853

History has not been kind to Bree's brief period in Victoria. Many histories have misinterpreted the "failure" of the contractor in erecting one of the Howe trusses, to be a total collapse of Brees Bridge, and hence a fault wrongly attributed directly to Brees. His short stint as acting Colonial Engineer and his departure have often been misread as a 'dismissal', when his position was clearly just a 'stop-gap' before Pasley arrived.

Brees's role is cast further into the shadows by the biographies of his successor, Pasley. *"His department, hitherto undermanned and demoralized, soon busied itself with port improvements and with the building of barracks, court-houses and offices throughout the settled districts."* [69] *"Pasley very quickly had many plans drawn up, including plans for Parliament House £250,000, and for Government House £90,000."*

After Brees had left the position, murmurings about him were aired in Parliament, and it was purported that some evidence was gathered, but the complaints appear to have come to nothing. [70]

Brees's family may have left Melbourne in September 1853, on the *'Roxburgh Castle',* although in October 1853, it appears that Brees was still living in Brighton, selling his books. [71]

Brees may have been in Bendigo for a while. He was living in Sydney between 1860 and 1865, where he spent his later working life as an artist, surveyor, engineer, and architect. His artwork, newspaper letters and articles about his drawings, paintings, surveying, engineering, architecture, and about his prior experiences in New Zealand provide evidence, and a picture of a busy man. He held an exhibition of 60 framed artworks in Sydney in August 1861, [72] and, in 1862, he joined his architect and artist son Harold in an "Architectural Gallery".

In New Zealand and Sydney, Brees is known for his many works of art, which are scattered in galleries and private collections. His drawings were

used as the basis of many published engravings, along with descriptive text about the places he visited. His portfolio of artistic work and his biography as an artist is becoming better documented, but is still incomplete. [73]

Brees died on 3 May 1865, aged 55, on board the ship *"La Hogue"* in East India Dock, Blackwall, London, having just arrived from Sydney. [74] [75] His Probate (Effects under £20) was settled in 1868, his wife Ann was then living at Fortress Green, Finchley, London. She died on 1 October 1882, at 6 Myrtle Terrace, Turnham Green, London. [76] [77] Many of their children married and stayed in NSW, his eldest son Harold dying there in 1904, and son Edgar in 1917.

5. George Holmes and Co.

The design and successful erection of the Howe truss bridge over the Saltwater River, can almost certainly be credited to Holmes, using skills, knowledge and experience he had gained working in North America. Edward Richardson who had lived and possibly also worked in North America, contributed.

Within the firm "George Holmes and Co.", Edward Richardson is the *"… and Co".* Sometimes the firm is mentioned as "Holmes and Richardson". Early contracts were awarded just to "George Holmes" so more research is needed to determine when the partnership actually commenced.

George Holmes was baptised at St Pauls' Church of Ireland, Newtown Forbes, County of Longford, Ireland on 23 Aug 1822. [78] His father was Alexander Holmes, a carpenter, and his mother Elizabeth. George was one of their six known children.

Alexander and family are said to have emigrated to Canada in 1846, where they settled at Huntley, Carleton County, Ontario. It is not clear if George went with the rest of the family. He is not in Huntley with the family in the 1851 Canada Census, where Alexander's occupation was recorded as 'carpenter', and son John was as 'B.Surveyor' (building surveyor?). [79] In the 1871 Census for Huntley, Alexander's occupation was 'farmer' [80] although in George Holmes' death certificate it was 'architect'. [81] Many builders designed as well as built houses, so it is not an unreasonable claim.

When giving evidence to the 1854 Parliamentary Commission enquiring into the best mode of providing for the *"Internal Communication"* of the colony, Holmes stated that he was a Civil Engineer who had worked in England, Scotland, the United States and Canada, and had been in the colony for about 18 months, arriving about November or December 1852. He had experience road making in England and Canada, and had been employed by the Central Road Board of Victoria for 14 months, but was now in private practice as a contractor. [82]

At a later enquiry on the *"Railway Department"* in 1859-60, [83] Holmes said that he had worked in Brunel's office for several years, probably in the period just before 1848, when he left England for the USA. On the passenger list for the *"American Eagle",* which departed St Katherine's Dock on 28 September and arrived in New York on 3 November 1848, were George Holmes, aged 27, engineer, and Margaret Holmes, aged 20. [84]

In the 1850 Census of New York State, George Homes (sic), 29, engineer, Margareth [sic], aged 21, and George H, 11 months, were residing in the City of Buffalo, County of Erie, State of New York. [85] Both George and Margaret are stated to have been born in England, and their child in New York (confirmed by his death certificate, which stated his birthplace to be Buffalo). [86]

Holmes, civil engineer, was listed in the *"Buffalo City Directory"* in 1850–51 and 1851–52, residing at the corner of Virginia and Niagara. [87] Before the next directory was due to be compiled, George, Margaret and their infant had packed their bags and departed for Melbourne. They are probably the 'G Holmes, wife and child', unassisted passengers on the *"Epaminondas"*, arriving in Melbourne in November 1852. [88]

Edward Richardson was baptised at St Paul, Canonbury, Islington, England, on 13 February 1831, [89] the son of Richard, a ship broker, and Elizabeth Sarah. Richard and Elizabeth Sarah Miller married by Banns at Christ Church, Southwark, England, on 14 October 1820. [90]

The family believes that the Richardsons immigrated to Canada in 1831, joining Richard's younger brother Hugh, who was a sea captain and ship owner. Richard was the first bank manager of the London, Ontario branch bank of Upper Canada. Richard died in London, Ontario in 1838, leaving a wife and seven children. Edward was educated in London, Ontario with his siblings and cousins (some New Zealand biographies inaccurately say London, England). His cousin Edwin Richardson was also a railway engineer, and may have worked with Edward in Australia and New Zealand. [91]

Richardson commenced his engineering career as a pupil under the resident engineer of the London and South Western Railway in 1845, after fulfilling his apprenticeship, he was for some years engaged in the locomotive department of the Great Southern and Western Railway of Ireland. [92] [93] [94]

The only arrival in Victoria of an E Richardson that matches his supposed arrival in Melbourne in 1852 is that of the unassisted passenger "E^{d}. Richardson" who arrived on the *"Great Britain"* from Liverpool via the Cape of Good Hope in November 1852. [95] No further details have been found to confirm this.

Edward Richardson married Margaret Higgins, second daughter of the late John Higgins, Esq., of Sligo, Ireland, on 13 May 1856, at St. James's Cathedral, Melbourne, by the Very Rev. the Dean, and afterwards at the residence of Patrick Higgins, Esq., Moonee Ponds, by the Rev. Matthew Downing. [96] [97]

Patrick Higgins was an uncle of Margaret. He was also a contractor, and his name is recorded against many contracts in Victoria. In May 1866, he was awarded the contract to build the Great Zig Zag Railway in NSW 1866–1869. This significant section of railway consisted of seven stone viaducts, varying in height from 10 to 70 feet, three tunnels, and nearly one and a quarter million cubic yards of excavations, two-thirds through rock.

Edward Richardson also had relatives in Victoria - an uncle William Marsh Miller, was an estate agent and later the first Town Clerk of Essendon.

Richardson and his wife, lived in Essendon, had two sons, Edward (born 23 March 1857 [98] [99]) and John Patrick (born 25 May 1858 [100] [101]), but John died an infant on 22 February 1859. [102] [103]

Edward Richardson, George Holmes and William Marsh Miller were all trustees of the St Thomas' Church of England, Essendon before 1862.

The period from 1852–1853 was a desperate time for the infant Colony. Victoria urgently needed infrastructure but the many private railway, bridge, and water companies that were floated were unable to get finance, and even though Governments could secure finance through guarantees, labour shortages meant higher prices, and plans for capital works were not able to be achieved.

Furthermore, private companies operations were usually design, construct and operate practices where expedience was important, compared with the very different operational needs and scrutiny of Government practices.

Many engineers, contractors, and speculators had immigrated to Victoria in the wake of the goldrush, in anticipation of boom times. But the lack of private capital and self-government administration systems meant they often had to be versatile, do other things, bide their time, and network with as many influential people as possible.

Engineers' training and skills in surveying, drawing, sketching, architecture as well as engineering and management could all be gainfully employed. At the time engineer Edward Dobson (1816–1908) [104] advocated that an *"engineer should endeavour to attain proficiency in rapid landscape-sketching" "it is well for a young engineer … to take every opportunity of graphically illustrating his reports, as a means of inspiring the confidence of his employers in the ability of their engineer".* [105] Engineer Edward Snell's diaries [106] describe the life of an engineer at this time in Victoria, and we know that Brees is remembered more for his artistic and writing abilities than for his engineering works.

From articles, advertisements and letters in newspapers, from submissions to Parliamentary committees, from notices in the Government Gazettes and from discussions and proceedings of learned societies, that both Holmes and Richardson were actively networking.

These were changing times. In December 1854, the organised rebellion of gold miners at Eureka Stockade in the Ballarat goldfields happened. By then, La Trobe had left, and his unpopular replacement Captain Sir Charles Hotham R.N. (1806–1855) [107] had arrived. In March 1854, the constitution, drafted by Andrew Clarke, was approved by Council. It gained Royal assent in July 1855, but it was not until November 1855 that Victoria was self-governing, and another year until the first elected Victorian parliament sat, in its new Parliament House.

Many new cultural and learned societies were established at this period, including the Philosophical Society of Victoria, and the VIAS. Almost from its commencement in 1854, "George Holmes, C.E., Engineer of Water Works", was a member and Councillor of the VAIS. Council members included the governor, Charles Hotham; the Attorney General, George Higginbotham, engineers Andrew Clarke, Charles Pasley, Alexander Kennedy Smith, and Matthew Bullock Jackson. So Holmes was networking closely with many of the key 'movers and shakers' of the period.

In May 1855, Holmes prepared a paper for the VAIS *"On the Timber of The Colony"*, [108] but in his absence, the paper was delivered by Richardson. Holmes described some of the native timbers, usually hard and tough woods, and their many uses in the colonies, including those for engineering purposes, such as *"Red and Blue gum for public works, such as railways, bridges, piles,"* and *"stringy bark … its immense size and straight grain renders it very useful where long piles are necessary".* In the Sydney Exhibition Catalogue, 245 varieties of native woods were listed and of

these *"22 produce excellent hard wood, 12 produce wood suitable for turning, 16 produce wood of considerable variety for cabinet making."* Except for comparative tests of iron bark with English Oak, Holmes was "*not aware of any experiments as to the relative strengths of timber grown in Australia,"* and he had *"contemplated a series of experiments on the relative strength of the several woods, but … had not been able to carry them out in time".*

The unusual shrinking of local timbers was noted *"most hard wood grown here, … when placed in works are much more liable to contraction longitudinally than European wood, therefore it behoves engineers, architects and builders, to make calculations accordingly. I have myself seen one-half an inch contraction in a piece of timber eight inches square by ten feet long."* Richardson noted also that soft woods *"of New Zealand shrank longitudinally, an unusual thing in England"* and that *"some Kaurie [sic] pine, used by him, had shrunk on fresh cuts being made after it had been felled two years."*

It is interesting to note that a month later, when Richardson presented his paper on *'The Keilor Bridge',* Francis Bell C.E. (*circa* 1821–1879) [109] also presented his paper on *'Wrought Iron Bridges as adapted to the Colony'*. [110] Bell and Richardson had both been engineers with the Great Southern and Western Railway of Ireland, as had Brees – Bell as a civil engineer and Richardson as a locomotive engineer. Holmes' earlier opinion about stringy bark piles may have been noted, as stringy bark piles were used in 1856 under the tall bluestone piers for Bell's Hawthorn Bridge [111], and are still in use today, nearly 160 years later.

Holmes continued his connection with the VAIS / Royal Society of Victoria, becoming a Life Member in 1857, and is listed on the Membership lists up to 1868, well after he moved to New Zealand. Richardson became a member on 8 March 1855, and is listed as a member to 1860.

Later, in December 1858, Holmes was elected a member of the recently formed Mining Institute of Victoria. [112]

As mentioned previously, Holmes was called to give evidence on many occasions before Parliamentary Select Committees. We have summarised Holmes' biographical details gleaned from these reports, but they also provide more details about his engineering skills, knowledge and works, as well as his contributions to the committees' recommendations.

In the 1854 Commission report on *"Internal Communication"* we gain the broadest and deepest understanding of the skills, knowledge and backgrounds of many of the engineers in the colony.

Holmes expressed his opinions about the best methods for road and railway construction in the colony, contrasting the difference in railway practices in England and in America – the former being expensive and the latter being built cheaper.

In America, provision for double track was made in the roadway, but by using single track, timber bridges, timber stations, level crossings, and avoiding tunnels, the initial costs could be kept down, then as the traffic increased, more permanent infrastructure could be provided. He had knowledge about the operations on the Albany New York railway, *"where twelve trains, or six each way with luggage trains at night"* on a single track line, and about the New York Erie Railway, that had more extensive works per mile than other railways. For railway works in Victoria, he suggested using 60lb rail and timber bridges and sleepers of blue gum. Then as traffic increased providing more permanent works later.

Holmes said that he had tendered for the formation of six miles of the Geelong Railway. He was asked for, and described a suggested route and estimate for the railway to Castlemaine.

For branch lines with little traffic, Holmes discussed the advantages of using lighter longitudinal planking, and lighter 'bars' where horse drawn trains or trams might be used, compared with heavier sleeper and rail construction for main lines.

In mentioned that in Canada these tram roads were used for the heaviest work, drawing timber, etc, and he discussed the operations of the Chippewa horse railway line to Niagara Falls.

He had also built plank roads in America, and described the method of diagonal planking.

Holmes had prepared an estimate for a tram road for the Plenty River (Yan Yean Water Supply) *"to be made in order to take up the iron pipes for the water works."* This tramway was built, but we have not been able to confirm his role in it.

He had contracted with the Corporation (City of Melbourne) for a portion of the north end of Elizabeth-street. the roads then being pitched and afterwards covered with blue stone metal. *"I have agreed to make a road three chains wide, and to form a metalled roadway in the centre forty feet wide; there is also a quantity of kerbing and channelling to be done. There are thirty-one chains in the whole, and I have tendered for it £10,690, being at the rate of £25,000 per mile."*

His discussion about rates of cartage shows a deep understanding of labour and the economics

of the period. He indicated that labour shortages were no longer a problem. In his contracts *"I ordinarily employ about two hundred men, and I find no difficulty in procuring them, as there are frequently more applicants than I have work for."*

In discussion about the most efficient construction methods for a railway to Castlemaine, Holmes recommended *"the plan adopted on the New York and Erie line, on which the works were very heavy, so much so that it was thought that letting the line to one man would have delayed the company too long; so it was let out in mile sections to different contractors, and in this way was done in a very short time and well."* This recommendation, of "sectioning" of contracts, was accepted by the committee and adopted by the Victorian Railways for building the main trunk lines.

He suggested that if materials and plant were purchased by the railway company, then a contractor could build the railway more easily and cheaper. *"If I had rails to lay down and dirt waggons at my disposal, I, as a contractor, could do the work much cheaper and better, and with more benefit to myself."* This suggestion was also taken up by Victorian Railways who later let bulk contracts for materials.

Holmes suggested that if a bridge was being built, and an engineer agent in England was appointed they could *"then go to some good house and give his orders, and the firm would not for their credit sake send out bad work."* Again this suggestion became the practice later adopted by the Victorian Railways for acquiring bridges from England.

Holmes also added that he would rather see a railway *"in the hands of a private company, as they can always get the work done cheaper than a Government, either here or in any other country. A Government is always looked upon by a contractor as fair game."* But this was not to be so, and the Victorian Government Railways took over all trunk rail lines - the Geelong to Melbourne, and Melbourne to Mount Alexander railways. The suburban lines remained as private companies.

6. The Wharf Contract 1854

In November 1854, "George Holmes and Co." were awarded a contract for the extension of the wharf on Yarra River, for £80,159-5-0 comprising 696 lineal yards of wharf and paving, plus sheds, with a completion of May 1855. "George Holmes and Co." here included George Holmes, Edward Richardson, Owen Connor, and Patrick Phelan. The contract appears to have been the largest single Victorian contract awarded at the time.

Others tenderers for the work, ranged in price from £35,000 to £82,000. [113] Many assertions about the tendering process, and about who was awarded the contract were made in the press, particularly *"The Age"* [114] [115], and this lead to questions in Parliament – if George Holmes and Co. was not the lowest tenderer, why did they obtain the work? Why did the Officers of the Royal Engineers recommend it? The complaints became even more bitter, when Holmes employed some of the unsuccessful bidders as sub-contractors.

In March 1855, a Parliamentary Select Committee was appointed to *"… enquire into and report upon the acceptance of Mr. Holmes's Tender for the Extension of the Wharf at Melbourne in preference to other Tenders of less amount."* In its report, tabled in Parliament in June 1855, with proceedings of the committee, minutes of evidence and appendices, [116] we gain a detailed insight into Holmes's operations, into the state of the construction industry and of the government tendering processes at the time of the contract.

In the evidence, it can been seen that the contracting and construction practices and processes of Holmes were well ahead of the contenders, with Holmes also providing bank guarantees for completion of his work.

Pasley, Colonial Engineer, in giving evidence, unequivocally stated the reasons "George Holmes and Co." had been recommended for the work, when no comparable work of this scale had been done previously in the Colony - Holmes had more experience in timber work, in road work, and in managing large labour teams than any other tenderer, and Holmes' tender price was realistic and close to his estimates.

Pasley specifically mentioned that:

- Holmes had built the bridge at Keilor "*from his own designs, and under his own superintendence"* and that with Holmes' long experience in timber work in America "*there is no better school for timber work than the United States"* and no other tenderer had comparable experience;
- that several contracts with both the Central Road Board and the Corporation of Melbourne had been "*executed very satisfactorily and quickly."*
- and regarding labour, "*when there was a great outcry raised about distress and want of work for the laboring people, the Road Board … set to work to make several miles of road, with instructions that the contractors were … bound to employ a large number of men within a very limited time, … Mr. Holmes was one of two persons who were selected by the Road Board … being a man who had shewn that he had a good deal of energy and who would get on quickly."*

Overall, including the 29 subcontractors employed, Holmes employed about 1500 different men to

complete the work, and had purchased equipment, such as a pile driver that he thought he would use on later jobs, or rent to other contractors.

George Holmes and Co. had by then successfully completed the contract. In short, the committee could find little fault with the contractor, or the work, and the many expert witnesses had few complaints about the high quality of the work. The only complaints were that variations were made to the contract, such as a macadamized roadway instead of a plank road, and the lowering of the road and wharf to match existing work. The only complaints from the wharf users were that *"the platform of the wharf has been made inconveniently wide",* but that change had been instigated by the board, not Holmes. The Committee recommended that *"the system of tendering for Public Works now in operation in the United Kingdom be adopted in Victoria"* even though it might entail additional expense.

7. South Yarra Waterworks Company 1855

In an advertisement 'South Yarra Waterworks Company' in *"The Argus"* 17 September 1855, [117] George Holmes C.E., Edward Richardson C.E., and Alexander Kennedy Smith C.E., are listed amongst the provisional directors, with the capital of the company £20,000, in two thousand shares of £10 each, with power of extension to £40,000.

A full description of the existing undertaking, completed in August 1854, is provided, as well as the proposed extensions to Prahran, Windsor and St Kilda. The basic system comprised a steam plant pumping water drawn from the Yarra River, to a tank on the South Yarra hill, and then gravity fed towards Prahran along Chapel Street, "*supplying water to the public from a fountain situate at the intersection of the Gardiner's Creek Road with Chapel-street, Prahran"* Mr William Robertson was the engineer of the Company. [118]

In January 1856, the works had been carried out, with the new tank at St Kilda Junction. The provisional directors (including Holmes and Richardson) stood down and four directors were elected for the ensuing year. [119]

Holmes tendered for the construction of Victoria's Parliament House but was unsuccessful. In April 1856, the stonemasons in Victoria achieved the world's first eight hour day. A Select Committee enquired into the effect it had on the contract for Parliament House. [120] and Holmes was called to give evidence.

8. Johnston Street Bridge 1856-1857

Figure 4: Johnston Street Bridge, photographed c1873. Constructed by George Holmes and Co., 1857, and propped after the floods of December 1863. [121]

The Johnston Street Bridge over the Yarra River, (Figure 4) was a large single span laminated timber arch bridge between tall bluestone abutments. The span was 170 feet, the longest in the colony. The abutment on the east side of the river was erected on solid rock, at an elevation of 30 feet from the level of the river, and the western side on piles averaging 25 feet in length, filled up with concrete to a depth of three feet. The height of the centre of the span of the arch from the level of the river was about 50 feet. [122] Contracts of £9,816-15-9 for the Stone Abutments, (awarded June 1856 with a completion of March 1857), and of £15,541-11-6 for the Timber Bridge (awarded February 1857 with a completion of November 1857) were awarded to George Holmes and Co. [123]

"The Argus" of 8 November 1856, describes the laying of the foundation stone for the Johnston Street Bridge on the previous day. This is the most incredibly detailed report about laying a foundation stone I have ever read – it describes everything - the people in the procession, the bands, the full details of the Masonic ceremony and all the details about the reception afterward. About 3000 people attended the ceremony, including the Provincial Grand Master, Captain Andrew Clarke R.E. M.L.C., who was presented with an inscribed silver trowel to mark the occasion. Afterwards about 400 to 500 sat down to a well provided collation at Abbotsford House, and many toasts and speeches were offered all round. These including toasts to the health of the bridge engineer, George William Harris C.E. (1819–1904), [124] to the contractor, George Holmes, and to Clement Hodgkinson, C.E. (1818–1893), the district engineer.

Laminated arch timber bridges had been recommended by the 1852 Parliamentary Select Committee on *"Roads and Bridges"*, as a way of economically constructing 'temporary' timber bridges over wide waterways, avoiding the need for piers that logs might build up against during

floods and damage or wash the bridge. A plan of a timber arch bridge was appended to its report.

Other laminated arch bridges of this type were built, including road bridges on the goldfields near Castlemaine and Clunes; the 1854 railway bridge over the Yarra River (90 feet central span) on the Melbourne Hobson's Bay Railway, [125] the 1857 multi-span Studley Park Road Bridge over the Yarra River at the northern end of Church Street; the road bridge over the Merri Creek on the Heidelberg Road at Northcote; and the 1862 Botanic Gardens footbridge. A very large five span laminated timber arch railway bridge was built at Singleton, NSW. [126]

At the time of its construction, the Johnston Street Bridge was thought to be high enough above the Yarra to avoid future flood damage, but when the very large flood swept through in December 1863, [127] [128] the lower part of the timber archway was lifted and warped and it became necessary to support the bridge with timber propping. [129]

Most laminated arch bridges proved to be unsuited to Australia conditions and climate, The only surviving laminated arch bridge in Australia is at Angle Vale in South Australia. [130]

In 1876, the Johnston Street Bridge superstructure was replaced with a wrought iron bridge, awarded to the contractor William Aitcheson Shand (1823–1877). [131] The new wrought iron box girder bridge, 22 feet wide with two 6 feet cantilevered footpaths, rested on roller bearings on top of the existing bluestone abutments that were raised 3 feet, and supported on two new slender cast iron column piers designed to minimise interference with the waterway. Thus providing three spans of about 60 feet each, with the girders continuous over the piers. [132] All the iron work for the bridge was manufactured on site by Mephan Ferguson (1843–1919) [133] - a son-in-law of the contractor W.A.Shand. The design engineer for the work was Charles Rowand C.E. (1825–1908), Roads and Bridges department, with George Donaldson C.E. (1826–1903), Railways department, as assistant-engineer.

The wrought iron through-girder design might have been practical for the design of a railway bridge but together with the tight bends in the roadway at both ends, the bridge was unsuited to motorised traffic. [134] Over many years it became *"Melbourne's worst bottle-neck, and one of its worst death-traps".* [135] From 1954 to 1957, the current wider straighter re-aligned cast-in-place reinforced concrete tee-beam and slab bridge was constructed in stages by the Country Roads Board using direct labour. [136] [137] [138] [139] [140] Only the downstream half of the new superstructure and half of the western abutment could be constructed while the old bridge remained in use.

When the new concrete bridge was finally completed in 1957, one hundred years after the original laminated timber arch bridge, the wrought iron bridge, *"the museum piece at the end of an arterial thoroughfare"* was finally sent to *"a junkdealer"*.

Today, still standing in Studley Park is the solid 1856 eastern bluestone abutment, with its three angled springing points for the laminated timber arches at its base, topped by the roller bearings for the 1876 wrought iron girders, and fenced by remnant sections of the 1876 riveted lattice handrail. Largely forgotten, its man-made rock face, known by local rock climbers as 'Mt Studley', is used as a 'bouldering' site.

9. Saltwater Railway Bridge 1858

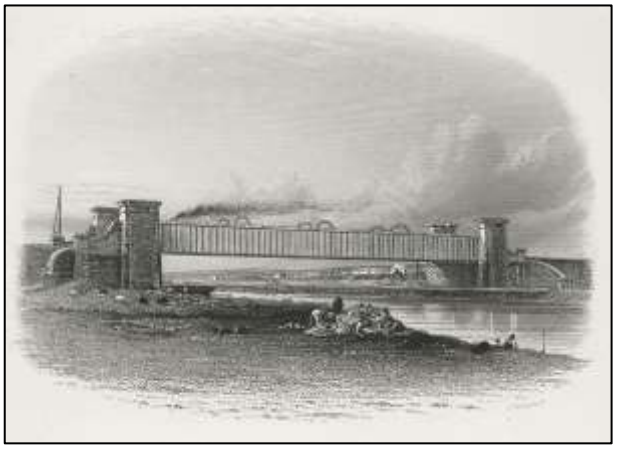

Figure 5: Saltwater River Railway Bridge on the Melbourne Mount Alexander and Murray River Railway, 1862. George Holmes and Co. contractors. [141]

The bridge over the Saltwater River on the Melbourne Mount Alexander and Murray River Railway (Figure 5) was a large through box-girder bridge, with a single span of 200 feet, and was, for more than 75 years, the longest span railway bridge in Australia. [142] [143] [144]

The *"First Report of the Proceedings of the Board of Land and Works"* 1859, [145] describes all of the works on the Victorian Railways, and details all the tenders, and contracts entered into during 1858. The following significant works on the Melbourne Williamstown Railway had been awarded to Geo. Holmes and Co.

- Cole-street, Williamstown, for the erection of the bridge, over the railway … £3,877-3-6
- Stoney Creek, for the foundations of the bridge, and extras ... £11,348-13-9
- Stoney Creek, for the erection of the 90 feet long iron girders for the bridge … £3,232-0-0
- Saltwater River, for the construction of the necessary staging, and the erection of the 200

feet long tubular iron girders, bridge, and extras … £30,331-15-6

Contractors Pierce and Dalziel were awarded the contract for building the bluestone abutments for the Saltwater River bridge, £31,737-0-0. Holmes had tendered for the work at a lesser price, as he had idle plant from the wharf contract, but was not awarded the contract. Later, in 1860, when presenting to the Parliamentary Select Committee upon *"Railways Department"* he argued that such bridge contracts should not be split, as determining blame for any faulty work could prove difficult to resolve.

In 1857, prior to being awarded the contract, Holmes had expressed his opinions about the railway company's practices and the arrangements for this bridge to the Select Committee on *"Railways".* [146] Now he had the contract, he needed to work with the former company people, now working for the Railways Department.

The 216 feet long, 15 feet high, wrought-iron box girders for the Saltwater River Bridge were fabricated in England by John Fairbairn and Sons, of Manchester, and the girders for the 90 feet Stoney Creek Bridge by Peto, Brassey, Betts and Co. The Saltwater Bridge box girder designs were significant, as they were different to the simple box girder in having two smaller boxes or cells forming the top flange of each box girder.

On 7 November 1856, Isambard Kingdom Brunel became associated with the bridge, when he was appointed as inspecting-engineer, by the Board of Trade in London, to superintend the carrying out of the works contracted with Messrs. Dalgety and Co. on behalf of the Victorian Government.

A copy of correspondence with Brunel is appended to the 1857 *"Report of the Select Committee upon Railways."* Brunel begged *"to suggest that in any future contracts, … considerable discretionary power should be left to such inspecting-engineer to modify the terms of the contracts, and particularly the mode of manufacture; the Engineer-in-chief taking care to specify in his instructions to the engineer in England, on what points, if any, he may wish a strict adherence to his drawings or specifications".*

Despite all the layers of notable engineers checking all the steps between the design, fabrication, trial erection, shipping and delivery to Melbourne, George Holmes still had major problems in assembling and erecting the bridge, as the plans provided to him by George Darbyshire, did not correspond with the bridge as shipped. In giving evidence to the 1860 Parliamentary Select Committee upon the *"Railway Department,"* Holmes describes the problems: *"The plans were grossly inaccurate", "so bad that Mr. Darbyshire was going to send home to England for an overseer from the Messrs. Farbairn to oversee the bridge; it came to a standstill." "drawings … were so different from plates, we had to throw them aside." "had to cut the plates and have castings, there was nearly £4,000 extra."*

Holmes had to put up the bridge without accurate plans, and there were many delays due to acknowledged problems with plans from Darbyshire's office.

"The rivet holes not coming one over the other; a practical man - a practical engineer, like Messrs. Fairbairn, had to make those deviations from the office plan that were absolutely necessary for the permanency of the work, and those alterations were not known by Mr. Darbyshire or his assistants, and they were so various and so numerous that the contractor was in a very curious mess; in fact, we had to work them out by our own experience; we had to track Messrs. Fairbairn's idea."

The first government railway from Melbourne to Williamstown (and connecting to Geelong) was finally completed and opened, as well as the line to Sunbury, on 13 January 1859. [147]

In 1912, to enable heavier railway traffic loads, Mephan Ferguson was contracted to replace the box girder span with a through hog-back Pratt steel truss structure, raised a few feet above the previous bridge level. The work was successfully undertaken without disrupting railway traffic and was completed in 1914. [148]

Today the 1914 steel truss railway bridge still stands on the 1858 bluestone abutments of the Saltwater Railway Bridge, and is still in constant use. It is of state significance and is included on the Victorian Heritage Register. [149]

The 90 ft span Stoney Creek Bridge was originally designed to cross over a future canal on Stoney Creek, but that never eventuated. Today, the bluestone abutments survive but have been altered and the superstructure has been replaced with shorter concrete spans over a central pier.

Today the Cole Street Railway Bridge at Williamstown, with its bluestone abutments and wrought iron plate girders, strengthened 1916, is still in use and is listed within the Hobson's Bay Heritage Study and Planning Heritage Overlay. [150]

George Holmes and Co. were awarded many other contracts on the main trunk railway lines, including the rail-over-road bridge at Dudley Street, West Melbourne. [151] At the same time, George was promoting the development of other projects,

including the *"Melbourne, Essendon and Kilmore Railway Company"*.

10. Melbourne and Essendon Railway 1859

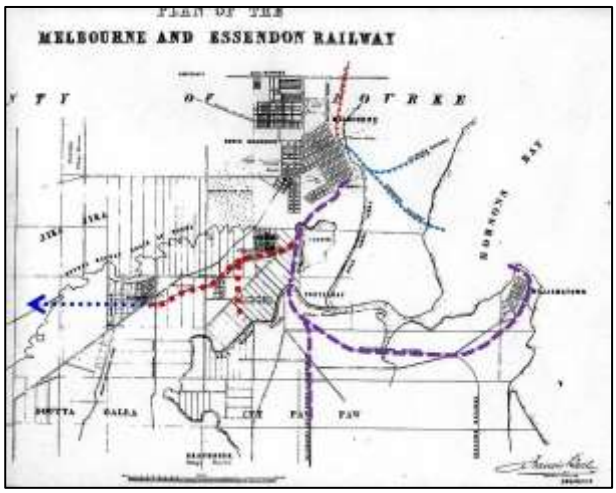

Figure 6: Melbourne and Essendon Railway, July 1859. Francis Bell, Engineer. George Holmes and Co., contractors. [152]

In November 1858, in the prospectus for the £50,000 *Melbourne, Essendon and Kilmore Railway Company*, George Holmes is listed as a Director, with Francis Bell C.E. as the engineer. [153] (Figure 6) The initial proposal was to build a 3.5 mile suburban track from the Government railway at North Melbourne to Essendon, then extend it to Broadmeadows, Kilmore, and beyond. Given that the Victorian government had the 'mandate' for country railways, this was a brave move, and not without its opponents.

Furthermore, unlike other Suburban Railway Companies, it was *"intended to use the Central Railway Depot, at the end of Collins-street, as a terminus, and to traverse the Murray River Railway across the swamp to a point adjoining Mr. Smith's brickworks, from whence the line will proceed directly for the new Cattle-yards and Essendon"*, and hence required leasing Victorian Railways lines and the terminus.

The company's bill was approved by Parliament [154] and George Holmes and Co. were awarded the contract to construct the railway.

On 23 July 1859, the Governor of Victoria, Henry Barkly (1815–1898), [155] performed the ceremony, for 'cutting the first turf'. He was escorted by the Victoria Mounted Artillery Corps, and that probably included Edward Richardson in uniform. Richardson had been promoted from Sergeant to Lieutenant on 7 Dec 1857, [156] and was later promoted to Captain on 30 May 1861. [157]

After many speeches and toasts all around:

"Mr. Holmes, in returning thanks, said that he felt proud to see so many of the citizens of Melbourne present on that occasion. He thought that if the Exploration Committee did not look out, the Melbourne and Essendon Railway Company would land their passengers at the Gulf of Carpentaria before the exploring party left Melbourne. (Laughter.)" [158]

And after indulging in refreshments and a cold collation at the "New Inn", the Governor mentioned that *"it is the intention of the company to make it the direct northern line to the Murray and to Sydney.."*

This was not the type of message you would really want broadcast, especially when you needed to build a co-operative arrangement with the Victorian Railways to lease their carriages, and run your trains on their tracks.

The line was completed in 18 months, and trains were operated to Essendon for the official opening on 22 Oct 1860, [159] again with speeches, toasts and a luncheon for 60 guests at George Holmes Moonee Ponds house *'Le Beau Sejour',* the guests having walked from the Moonee Ponds station along a road, later named Holmes Road. [160] Regular railway services commenced from 1 Nov 1860. There were five intermediate stations on the line, Kensington, Newmarket, Ascot Vale, and Moonee Ponds.

On 28 February 1861, a short branch line was opened from Newmarket to Flemington Racecourse, in time for the running of the first Melbourne Cup in November of that year. Robert Cooper Bagot (1828-1881) [161] another local civil engineer, was the main driving force in establishing, designing and developing the racecourse and the branch line. By now, Holmes was a major share-holder in the Railway company, and was probably benefitting from the land boom that followed the opening of the railway. [162]

Also in February 1861, George Holmes and Co. were awarded the contract, by the St Kilda and Brighton Railway Company, to extend the railway from North Brighton (Bay Street) to Brighton Beach for £25,000. [163] [164] The work also included the construction of the Brighton pier, and the short pedestrian tunnel between the end of the Brighton Beach station and pier. The completed railway line to Brighton Pier was opened on 20 December 1861, with a special train from Melbourne, followed by a lunch at the Royal Hotel. After many toasts all round, …

"Mr. Holmes, in returning thanks, said that at one time he had intended to go to the Gulf of Carpentaria, but, meeting the bay on every side, he stopped at Brighton, and he considered it a right direction. It was but a little time ago since

Canada had but twelve miles of rail ; it was now a perfect network of railways; and he hoped strongly to see the mere 2,000 miles between this and Carpentaria shortly covered in the same manner, (Laughter.)" [165]

By then Holmes and Richardson were ready to move to New Zealand - on 16 April 1861 they had agreed to carry out the contract to build the Christchurch to Lyttelton railway and tunnel, on the proviso that *"the description corresponded with the fact".*

Sadly, on the 28 April 1861, Richardson's wife Margaret died, aged 28 years, [166] [167] and very soon after all his household possessions were sold [168] in preparation for a permanent move to New Zealand.

Like most private railway companies then, the Melbourne - Essendon Railway Company's income barely covered its operating costs, it was unable to service the rising costs of its borrowings, pay dividends, or gain approval to extend the line – and that would probably have been seen as too much of a threat to the Victorian Railway's trunk lines.

The 1860 Parliamentary Select Committee on the *"Railways Department"*, heard evidence from engineers and contractors, many associated with the private suburban Railway Companies, including Holmes. The report was rather damning of the Railways Department and the Engineer-in-Chief, George Christian Darbyshire (1820–1898), and he resigned on 5 May 1860. [169] Thomas Higinbotham, the brother of George Higinbotham, Attorney General, was appointed Engineer-in-Chief. Many of Darbyshire's key engineers left shortly after Higinbotham took office. Higinbotham was unsympathetic to the suburban lines, and he later had many disagreements with other engineers, and appears to have lacked practical detailed applied engineering knowledge and skills.

The Essendon Railway directors by now were committed to negotiating a sale price, but the process dragged on. Without having come to any agreement with the government, the company closed the line on 1 July 1864.

The line was finally purchased by the government for £22,500 in August 1867, at that stage it was in a serious state of disrepair beyond Newmarket. The Flemington Racecourse line was re-opened in time for the 1867 Melbourne Cup and after 7 years, in 1871, the line was finally re-opened to Essendon.

The 'North East line' was quickly extended in sections beyond Essendon in 1872–73. The line was open as far as Wodonga on 21 November 1873, linking at Albury with the main railway line to Sydney. And these days, linking to Brisbane and beyond towards the Gulf of Carpentaria.

The other three private suburban railway companies in Melbourne merged in 1865 to become the Melbourne and Hobsons Bay United Railway Company, and they too were eventually purchased and became part of Victorian Railways in 1878.

11. Holmes and Richardson in New Zealand

Little needs to be said here about the construction of the Lyttelton to Christchurch Railway. There are many excellent contemporary papers describing the construction including those of Dobson, the engineer for the Province of Canterbury, and the engineer for the railway. [170] [171] [172] However a few key points are worth repeating.

The tunnel was one of the most significant engineering achievements in New Zealand. It was the first rail tunnel in New Zealand, and for many years the longest tunnel. It was the first tunnel in the world through the wall of an extinct volcano and provided a unique insight into the geology of a volcano. This also posed unique engineering problems dealing with the changing strata. The syphon for drainage of the upper half of the tunnel was the longest in the world, and the ventilation system was so successful that it was used in constructing the Mont Cenis tunnel from Italy to France.

The agreement to construct the Lyttelton and Christchurch Railway over a period of five years from 1 June 1861, for a sum of £240,500, including the 2,838 yards long tunnel and stone portals for £195,000 was signed on 1 May 1861. The full text of the contract was reported in the *"Lyttelton Times"*, 22 May 1861. [173]

Construction of the tunnel began in July 1861, and the line was opened in December 1867. The contractor had to manage maintaining the labour force over a period of six years, through two gold rushes, and the difficulties of the work site. In the end, both Holmes and Richardson were paid in land grants by the Provincial Government.

Holmes built the first part of the line between Christchurch and a temporary terminus at the Ferrymead wharf and the line started operating from December 1863. Locomotives and rolling stock were brought in parts over the Sumner bar and assembled in the open. As the line was the 'Irish Gauge' of 5 feet 3 inches, the unused locomotive from the Melbourne to Essendon Railway, that was built by Slaughter Gruning & Co. of Bristol, was acquired and used as an engine for ballasting duties.

George Holmes and Co. were also contractors for other works in the Province, including the railway

line south from Christchurch to the Rakaia River, and the Iron Swing Bridge, over the Heathcote River on the Sumner Road This interesting timber bridge with a central iron swing span providing two openings of 31 feet each, was built 1862–1864, for about £5,500. The swing bridge replaced the ferry service, and it could be readily opened for the passage of vessels by a single person.

12. Conclusion

The lives and engineering works in Victoria of our three engineers - Samuel Brees, Edward Richardson, and George Holmes – who first came together to build Brees Bridge, were true engineering pioneers. Tackling tasks that many others would not dare to attempt, and in doing so, have left us richer for their endeavours. This paper has helped fill many gaps, but more research needs to be done before a thorough catalogue of their works can be completed.

Not long after the completion of the railroad to Christchurch, in November 1868, Dobson moved to Melbourne to take up a two year appointment as engineer for the Melbourne suburban railways, and then worked for five years on water supply works in Geelong and Malmsbury, Victoria, before returning to New Zealand in 1876.

Richardson married again and had another family. He became a politician, including terms as the Minister of Public Works for New Zealand. Of the Department's Ministers in the 20 years to 1890, *"only E. Richardson had any technical knowledge – he was a qualified engineer".* [174] Many biographies have been written about him. [175] Some of Richardson's relatives came to New Zealand to assist with construction works, so more research in this field would be worthwhile.

Holmes was associated with many large properties and homes, and purchased *Huntley*, at Riccarton in 1877, where he died on 21 September 1877, aged 55. His only son George died shortly after, so his estate was passed to his brother John Holmes. John was a surveyor and a notable politician in Canada, who later moved to New Zealand. Many of Holmes' nephews and other relatives who had assisted him with managing the tunnel works, also became large property owners in Canterbury.

Today, historic *Huntley* still survives, but the large homes of Holmes and Richardson in Essendon, Victoria have been demolished. Their names live on in the streets in Essendon, Victoria, and in Holmes Park in Riccarton, Christchurch, New Zealand.

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Brees's Surveying and Levelling, 15s.
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