ENGINEERS AUSTRALIA

ENGINEERING HERITAGE AUSTRALIA

HERITAGE RECOGNITION PROGRAM

Nomination Document for

THE SOMERSET DAM

Somerset Region
South-east Queensland
January 2010

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Heritage Award Nomination Form

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of work: **The Somerset Dam**

Engineering Heritage Australia (Queensland) (EHAQ) hereby nominates the above-named work for the award of a **National Engineering Heritage Landmark**.

Location: **Somerset Dam Qld 4312**

Owner: **Seqwater, PO Box 15236, City East (Brisbane) QLD 4002**

EHAQ, the nominating body, has advised the owner of this nomination and a letter of support is attached**.**

Access to site: **Public viewing platform beside Esk-Kilcoy Road.**

Andrew Barnes

Chair, Engineering Heritage Australia (Queensland)

Introduction

Background: the floods of 1893

The Stanley River is the main tributary of the Brisbane River. Closer to the Queensland coast, its catchment is much wetter than that of the Brisbane. In February 1893, two major cyclones a fortnight apart, (one before and one after a lesser cyclone) dropped heavy and extended rain over the Blackall Range, where the Stanley River rises. Henry Plantagenet Somerset, from his homestead "Caboonbah" high above the river, observed flood waters rising rapidly in the river below. Realising the flood's potential danger to surrounding districts, Somerset dispatched a messenger on horseback to Esk to telegraph Brisbane of the impending danger. Two weeks later when the river rose seriously again, the Esk telegraph line being down, Somerset rowed across the flooded Brisbane River, two horses swimming in tow, to send a rider across the d'Aguilar Range to Caboolture to telegraph Brisbane. The first message was ignored or misinterpreted, but as a result of Somerset's efforts, Caboonbah became Queensland's first flood warning station, with a telegraph line to Cressbrook Station carrying a family operated Morse for 8½ years until a telephone line was installed in the early 1900s. The flood warning station was manned by the Somersets for 40 years, 1893-1933.

Following the devastation of the 1893 floods on the Brisbane River Valley, flood mitigation schemes were proposed to control the run-off of the Brisbane and Stanley Rivers. Also, the 1901-1902 drought highlighted the need for water storage above Mt Crosby pumping station to meet Brisbane's growing water consumption. In 1906, when the Brisbane Board of Waterworks was considering use of the lake on Stradbroke Island to augment Brisbane's water supply, Somerset invited the Board to send an engineer to inspect the Stanley Gorge, suggesting that a dam across the gorge would serve two purposes: flood mitigation in the Brisbane River Valley, and increased storage for Brisbane's water supply. An eminent American engineer, Allen Hazen inspected the site and agreed that it had potential for future development, but recommended that a dam on Cabbage Tree Creek would solve Brisbane's more immediate needs, for water storage. The Cabbage Tree Creek dam, known as Lake Manchester from 1922, was completed in 1916, sidelining the Stanley River proposal.

The late 1920s

A succession of three Brisbane River floods between 1927 and 1931 restored interest in the Stanley River proposal, for a dam of the Stanley approximately 8km upstream of its confluence with the Brisbane, to provide augmented water storage and substantial flood mitigation.

The 1930s

This nomination captures in some detail the extraordinarily innovative engineering that the Stanley River Works Board applied to the dam in the 1930s under the leadership of its Chief Engineer WHR Nimmo. By the time of completion of the dam, the Board had employed no fewer than eight engineers who were eventually to be recognised in the publications "Eminent Queensland Engineers".

The vast majority of the supporting information is the result of research by Geoffrey Cossins, who effectively operated the dam for the Brisbane City Council from the dam's formal completion in 1959 until his retirement some 25 years later. Attention is drawn particularly to the closing paragraphs of his paper Appendix "A".

Date: ....

11 JAN 2010

seqwater
WATER FOR LIFE

23 December 2009

Engineers Australia – Queensland Division
Engineering House
447 Upper Edward Street
BRISBANE QLD 4000

Dear Sir/Madam

PROPOSAL TO NOMINATE SOMERSET DAM FOR ENGINEERING HERITAGE RECOGNITION

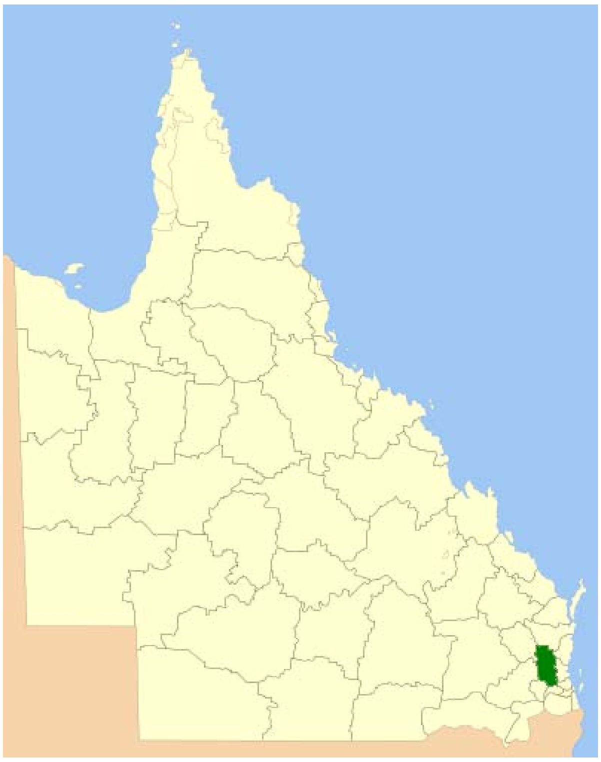
I refer to our discussions regarding the nomination of Somerset Dam for engineering heritage recognition. I wish to advise that Seqwater supports the nomination and we look forward to working with you on this project.

Yours sincerely

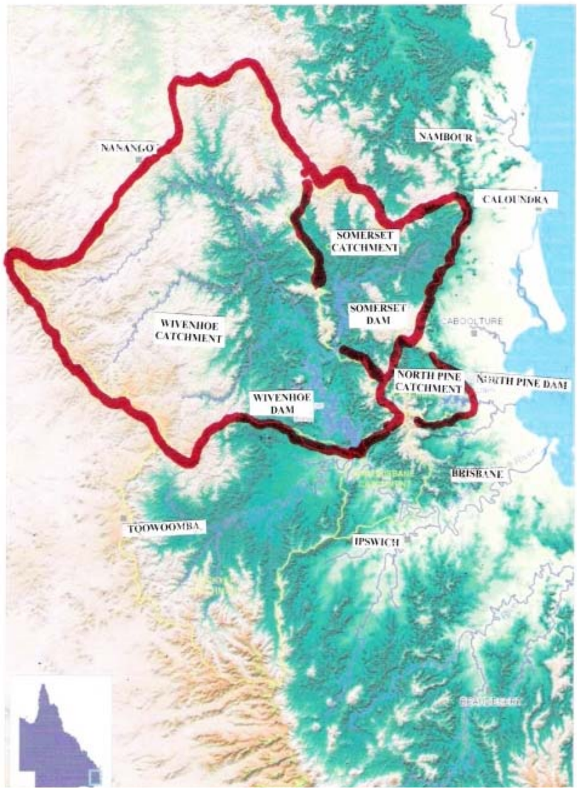
Peter Borrows
Chief Executive Officer

Queensland Bulk Water Supply Authority (trading as Seqwater) | ABN 75 450 239 876 | Corporate Office: Level 3, 240 Margaret Street Brisbane, Queensland | Ph 07 3229 3399 | www.seqwater.com.au

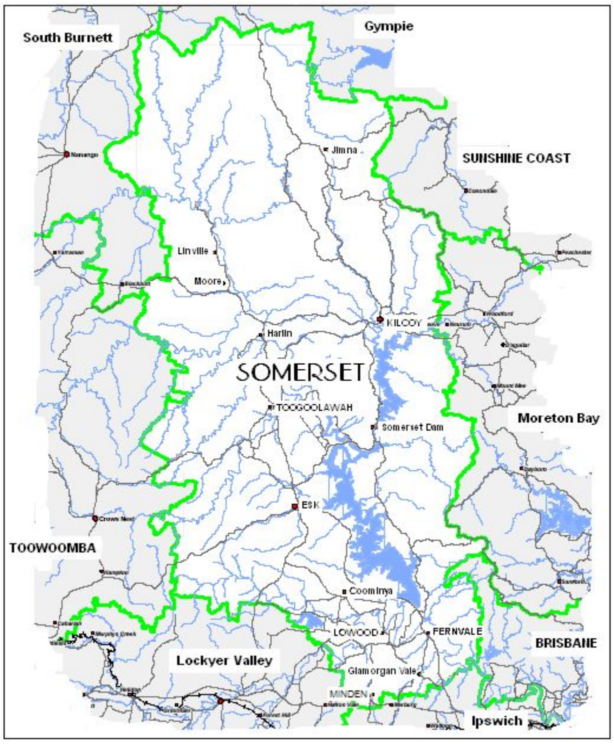
All correspondence to: PO Box 16146, City East QLD 4002



Somerset Local Government Region, Queensland



Catchments of Brisbane, North Pine and Stanley Rivers



Somerset Region 2008

HERITAGE ASSESSMENT

1. BASIC DATA

Item name:	**The Somerset Dam**
Other / Former names:	**Silverton Dam, the Stanley River Dam**
Location:	**Co-ordinates of centre of dam wall upstream face** **Latitude 27° 6'54.45"S** **Longitude 152°33'23.00"E** **MGA Coordinates 456030E 7000735N**
Address:	**Esk-Kilcoy Road, Somerset Dam, Qld 4312**
Suburb/Nearest Town:	**Somerset Dam**
Local Government Area:	**Somerset Region**
State:	**Queensland**
Owner:	**Seqwater**
Current Use:	**Water storage, flood mitigation, recreational water sports**
Former Use:	**Electricity generation (currently shut down undergoing automation/refurbishment)**
Designer & Builder:	**Stanley River Works Board**
Year Started:	**1935**
Year Completed:	**1959**
Physical Description:	**Please refer to attached paper Appendix "A" Sections 8. & 9. This nomination is of the dam monolith and its appurtenances, the township and the surviving remains and foundations of construction equipment, particularly the remaining cableway tower on rails at the eastern end of the monolith.**
Physical Condition:	**Excellent, fully functional for water storage and flood mitigation.**
Modifications and Dates:	**Hydro-electric station refurbishment 1987-88, 2009-10.**
Heritage Listings:	**None**

Engineers Australia recognises that this nomination is of a serviceable live system. If the nomination is successful, Engineers Australia will have neither rights nor responsibilities in relation to the operation, maintenance or upgrading (including automation) of the system or any part of it.

2. STATEMENT OF SIGNIFICANCE:

Historical significance

The Stanley River, the major tributary of the Brisbane River, is closer to the Queensland coast and consequently has a catchment considerably wetter than that of the Brisbane. Until it was dammed, it was a major contributor to most of Brisbane's floods. The history of Somerset Dam can be traced first back to the disastrous triple floodings of Brisbane and Ipswich in February 1893, prior to which **Henry Plantagenet Somerset**, grazier (and later Member for Stanley in the Queensland Parliament from 1904 to 1920), sent a message urgently to Brisbane about the flood he saw flowing rapidly down the Stanley River gorge, visible from his homestead "Caboonbah". He dispatched a rider to telegraph Brisbane with advance warning of the first of the three disastrous floods of February 1893: the flood had reached the level of the 1890 flood, and was still rising. He was to repeat this action a fortnight later when he witnessed the beginnings of the third of the floods of that month.

In 1893, the coal-fired steam-powered Brisbane River pumping stations for Brisbane's and Ipswich's water supply (at Mount Crosby and Kholo respectively) were restored soon after the floods. The un-dammed channel of the Brisbane River beside the pumping stations provided for most of the cities' water storage for a further 30 years. Despite the completion in 1916 of the Cabbage Tree Creek dam, (to be known from 1922 as Lake Manchester), Brisbane's steady growth after the 1914-18 war necessitated a major increase in water storage. In 1922, Ipswich City Council retired its Kholo pumping station and drew its supplies thereafter from Mt Crosby. In 1926, close upstream of its Mt Crosby pumping station beside the Brisbane River, the water supply authority of the day, the Metropolitan Water Supply and Sewerage Board (MWSB), built a weir/bridge across Brisbane River and an intake tower as an interim storage measure.

In the late 1920s, there was a generation of South-east Queenslanders with first hand experience and memories of the floods of February 1893. The sequence of significant Brisbane River floods in 1927, 1928 and 1931, in combination with inadequate water storage and serious unemployment, set the scene for the construction, across the Stanley River, close upstream from its confluence with the Brisbane River, of Australia's first dam designed specifically to provide significant flood mitigation.

A 1934 Act of Parliament established the Stanley River Works Board to design and construct the Stanley River Dam and its construction village, both eventually to be named Somerset Dam. The dam is a straight mass concrete structure, of which further details are at section 8 of Appendix "A". The relationship between water supply storage and flood mitigation compartments was set, and remains, at 40%:60%.

Work started in 1935. By 1942, progress had enabled sufficient storage of water to provide the Mt Crosby water supply pumping station with its first reliable long term water storage. Construction halted, to enable diversion of the work force and plant to urgent wartime construction of the Cairncross graving dock in the Quarries Reach of the Brisbane River at Morningside. Work on the dam resumed in 1948. Concreting was completed in 1953,

Soon after completion of concreting, the dam almost totally mitigated damage by the 1955 flood to Brisbane and Ipswich. The dam next demonstrated this capability in 1974, when, without Somerset's major mitigation of that flood, the catastrophic damage bill in the cities would have more than doubled.

It was decided at the outset to equip the dam with a hydro-electric power station, which has proved to be a remarkable asset. The 4MW station, first commissioned in 1953, is the oldest power station still to supply power to the interconnected Queensland electricity grid. It has provided a reliable, strategic and economic benefit to the northern and western portion of the rural 33kv distribution network. The history to date of the facility has been well recorded, and it is hoped that the work of its automation and subsequent operation will be similarly recorded.

Association with important group

The first chairman of the Stanley River Works Board was John (later Sir John) Kemp, M.E., M.Inst.C.E., M.I.E.Aust., then the first Commissioner of Main Roads, later to become the first Co-ordinator-general of Public Works. A long-time member of the board was John Douglas Story. He served on boards which (i) constructed the new university at St Lucia, (ii) built Somerset Dam, and (iii) erected the Brisbane River bridge named in his honour in 1940. He was further honoured in 1965 by the naming of the university's new J.D. Story Administration Building.

Several Eminent Queensland Engineers made major contributions to the design and construction of the dam. Chief Engineer from 1934 to 1949 was W.H.R. (Bill) Nimmo, M.C.E., M.Inst.C.E., M.I.E.Aust., (Designing Engineer, then Chief Engineer and later Commissioner for Irrigation and Water Supply).

Nimmo's first Assistant Engineer for Design, C.B. (Charles) Mott, M.E., M.I.E.Aust., was seconded to the project for three years from his then position of Designing Engineer, Department of Works, Brisbane City Council, to design the construction village and access to and from the construction site. Mott was later succeeded by E.M. (Mick) Shepherd, M.E., M.I.E.Aust

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The first Resident Engineer for Construction was Glenister Sheil, B.C.E., B.M.E., B.Sc., M.I.E.Aust., succeeded in 1941 by E.L. (Evan) Richard, B.C.E., A.M.I.E.Aust. From 1948 to completion in 1959, R.deV. (Raleigh) Gipps, B.E. (Civil), F.I.E.Aust. was the last Resident Engineer.

Other Eminent Queensland Engineers, employed by or otherwise involved with the Stanley River Works Board, included HG (Humphrey) Brameld, JD (Jack) Cronin, WJ (Walter) Doak, W (Bill) Hansen, JA (Jim, later Sir James) Holt.

<u>Creative or technical achievement</u>

Somerset is Australia’s first dam designed specifically to provide a combination of water supply and flood mitigation. Like any major dam, it is aesthetically distinctive and a significant landmark. Engineers introduced several other innovations, detailed in section 13 of Appendix "A".

Social/cultural

Somerset Dam is outstanding because of its integrity and the esteem in which it is held, *inter alia* by water sports enthusiasts. The Dam is important for its water supply to the cities of South-east Queensland and is vital to those cities’ sense of place in consideration of the flood mitigation it provides for the many low-lying properties downstream.

The construction village has not been dismantled. The land has been subdivided and properties improved with cottages and other buildings have been sold to private owners and operators. The township is now largely the domain of water sports enthusiasts and their families: upstream water ski-ing, sailing and swimming, downstream canoe-ing and kayak-ing. One canoe club would co-ordinate its outings with controlled week-end releases from the dam, pre-arranged with the Brisbane City Council, to optimise conditions downstream in the Brisbane River, through idyllic riparian scenery. The Brisbane Valley 100 is an annual weekend charity event, 100 kilometres from Somerset to Kholo, with an overnight camp at approximately half-way. The event continues, water hyacinth permitting, and adjusted to take account of Wivenhoe Dam.

Rarity

Somerset Dam is the first of the only two combined water supply and flood mitigation dams designed as such in Australia, the other being Wivenhoe Dam (1984), into which the Somerset overflow now discharges.

Integrity/Intactness

The dam is very dry internally, resulting from close attention to construction practices such as weigh-batching, placement from bottom dump buckets rather than chutes, and control of air entrainment.

Proposed wording for interpretation panel

A History of Somerset Dam

Somerset Dam was named to honour Henry Plantagenet Somerset, a prominent member of the Brisbane Valley community and Member for Stanley in the Queensland Parliament from 1904 to 1920. Somerset dispatched a rider to telegraph Brisbane with advance warning of the first of the disastrous floods of February 1893, repeating the action a fortnight later to warn of the third (and second major) flood of that month. After the severe drought of 1899-1902, Somerset actively promoted a dam at Stanley Gorge with the dual purpose of flood mitigation and water storage.

Planning the dam

Floods occurred in 1927, 1928 and 1931, following which, in 1933, the Bureau of Industry recommended the damming of the Stanley River, 8km upstream of its inflow to the Brisbane River. A 1934 Act of Parliament established the Stanley River Works Board, chaired by engineer Sir John Kemp, M.E., M.Inst.C.E., M.I.E.Aust.

Construction progress

Construction started in 1935 on the township and the dam wall, providing substantial unemployment relief during the 1930s depression. Construction of the dam had advanced sufficiently by 1942 to provide the Mt Crosby water supply pumping station with its first reliable long term water storage. Construction ceased during World War II and resumed in 1948. Concrete work was completed in 1953. Careful quality control of mix and placing of concrete has resulted in Australia's driest dam interior. Queensland Premier Frank Nicklin officially named Somerset Dam in 1959. Some 450 workers were employed during construction, and the township population exceeded 1000. Some of the township has been preserved and improved, providing accommodation today for scores of water sports enthusiasts.

Flood mitigation

This was the first major dam in Australia designed specifically to provide flood mitigation as well as storage for urban water supply. Soon after completion, the dam almost totally mitigated damage to Brisbane and Ipswich by the 1955 flood. The dam next demonstrated its capability in 1974, when, without its major mitigation of that flood, the catastrophic damage bill would have more than doubled.

Hydro-electricity

The small (4MVA) hydro-electric power station was first commissioned in 1953, and overhauled in 1987 and 2010. The oldest grid-connected hydro-electric station operating in Queensland, it has supplied power economically to the Somerset region rural network and provided valuable operational support of the grid during peak loads and storm outages.

The Engineers

Several eminent engineers made major contributions to the design and construction of the dam. Chief Engineer from 1934 to 1949 was W.H.R.(Bill) Nimmo, M.C.E., M.Inst.C.E., M.I.E.Aust., with his first Assistant Engineer for Design, C.B.(Charles) Mott, M.E., M.I.E.Aust., who was later succeeded by E.M.(Mick) Shepherd, M.E., M.I.E.Aust.

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Seqwater logo	2010	EA logo

Appendix “A” is an abbreviation of the paper *‘The Overlooked Heritage of Somerset Dam: A story of droughts, floods, disagreeable water and lost chances’* presented by Geoffrey Cossins to the Twelfth National Conference on Engineering Heritage at Toowoomba in 2003. Cossins was for many years the Brisbane City Council’s Water Investigations Engineer, and was responsible for the operation of the Somerset Dam flood mitigation during the Australia Day floods of the Brisbane River in 1974.

The Somerset Dam

Geoffrey Cossins BE, MIEAust, MAWA.

PREAMBLE

Somerset Dam is situated on the Stanley River approximately 220km upstream from the mouth of the Brisbane River. The adjacent township is named after it, and was the site of the original workers camp. The dam itself was named after local grazier Henry Plantagenet Somerset, M.L.A. for Stanley in the Queensland Parliament from 1904 - 1920. Somerset, seeing from his homestead “Caboonbah” a ‘wall of water’ coming down the Stanley River in February 1893, despatched a message of warning by horseback to the town of Brisbane.

This dam, near Esk in South East Queensland, was the first large Australian dam to provide significant, controllable flood mitigation and to combine this function with urban water storage in the one structure. It was also the first to adopt cone type discharge regulators, tractor type sluice gates and spillway sector gates. The Stanley River Works Board, builder of the dam, shares with the Tennessee Valley Authority a world first in locating high pressure sluices beneath spillway sector gates. Other practices introduced for the first time in Australia included the use of unit graphs for the design hydrograph, model experiments for the dissipator, sluice and emergency coaster gate design, concrete permeability measurement and air entrainment. It incorporated the most advanced Australian design and construction features for its time and was the second Australian dam for which all concrete materials were weigh-batched and concrete consolidated by vibration. A substantial construction village was built, much of which is still intact. At its completion in 1959 it had the highest storage to capital cost ratio as well as effective flood mitigation for the country’s largest flood-prone population. It relieved the chronic headworks water storage problem for the cities of Brisbane and Ipswich as well as providing employment during the 1930s depression. A workforce was trained which was invaluable for the construction of northern defence works to resist the advance of Japanese forces during the Second World War. In view of the above it would appear that Somerset Dam is a worthy candidate for an award by Engineering Heritage Australia.

The Sections of the Paper

1. SOMERSET DAM'S PREDECESSORS: PREVIOUS WATER SUPPLY SOURCES FOR BRISBANE

The earliest water supply histories of the convict settlements Brisbane, Hobart and Sydney are very similar. The Tank Stream, the Hobart Rivulet and The Big (aka Wheat) Creek were first dammed, using convict labour, and then polluted. These in-town storages were then replaced by more sophisticated works upstream of and remote from the British colonists and their polluting life style.

A convict-built earth bank across Brisbane's Wheat Creek converted a swamp into a shallow reservoir in 1828 and this had to make do, grossly polluted, and frequently running dry, until a reticulated water supply, gravity fed by Enoggera Dam, was commissioned by the Colonial Government in 1866, reducing the price of water by a factor of 10 (Brady 1866). A most thorough analysis of all available hydrological data (of which there was little) and an examination by the Board of Waterworks of alternative sources indicated Gold Creek as the next source of supply (Henderson 1880); but, even as the dam was being built, the droughts of the 1880s showed that the small local catchments capable of gravity supplies would always be inadequate. Attention was turned to the Brisbane River which actually stopped flowing at Mount Crosby during the 1886 investigation (Cossins 2000). Nevertheless, the Board of Waterworks commissioned a steam powered pumping station there in 1892. No dam was provided, and water was drawn from a submerged inlet constructed in the bank of the river close downstream of the pumping station. A weir was later (1926) built close upstream of the station, with a new intake close upstream of the weir. In 1907, the Board took expert advice from the distinguished American engineer, Allen Hazen, who recommended *inter alia* that development of the Brisbane River with a storage dam would be more economical than the several alternatives proposed. The old (appointed) Board was replaced in 1909 by the (elected) Metropolitan Water and Sewerage Board (MWSB), later the Metropolitan Water Supply and Sewerage Board (MWSSB). In 1922, the City of Ipswich opted to take a bulk supply of treated water from the MWSSB's Mount Crosby plant rather than replace its worn out (1893) Kholo pumping station, also on the Brisbane River.

The building of the 38 metre high mass concrete Lake Manchester gravity dam on Cabbage Tree Creek, a Brisbane River tributary a short distance upstream of Mt Crosby, was Hazen's only poor recommendation. The catchment is small and its location in a rain shadow of the D'Aguilar Range results in a poor yield. The lake was also too large in the circumstances and lost a large amount of water by evaporation. Hazen preferred this location on a tributary creek instead of on the main Brisbane River in order to avoid siltation. The deficiencies became apparent immediately on completion of the dam in 1916, a series of droughts immediately showing its inadequacy. The same amount of concrete at the Somerset site would have produced a much greater water yield (Nimmo 1933).

2. THE STANLEY RIVER SITE

The Water Board's attention then turned to a rocky gorge between Mount Brisbane and Little Mount Brisbane on the Stanley River, the main tributary of the Brisbane River. It had been identified as a potential storage site and a cross section taken in 1896 during the survey of the 1893 flood levels right up the Brisbane River to the Stanley junction and then up that stream to Woodford. In 1906 Henry Plantagenet Somerset, after whom the dam is named, led a Water Board engineer to the site and Allen Hazen briefly considered it in his investigations. Using a log-log plot (to the great amazement of the locals) he accurately extrapolated the storage basin contour survey of the earlier Middle Creek site (Pennycuick 1899), which extended up the Stanley River, to give fairly accurate storage characteristics of the Stanley River site. Starting in the early 1920s, a survey was made of the dam site and storage basin, and a gravity dam was designed with about the present dimensions but with a side spillway.

1928: The Royal Commission's recommendation

The Queensland Government, however, was not satisfied with the Water Board's performance in raising huge loans in London and New York, nor, in particular, with a consortium of Board members and associates who were buying up the ponded area of a proposed dam on the Coomera River. A Royal Commission was set up to investigate the future requirements of Brisbane (also, by this time, of Ipswich) for both water supply and flood mitigation. The Commission, after considering a number of proposed sources, recommended a combined water supply and flood mitigation dam on either the Brisbane River or its main tributary, the Stanley (Gutteridge 1928).

Selection by the Greater Brisbane City Council of site and dam type.

The MWSSB was disbanded in 1928 to become the Water Supply and Sewerage Department of the Brisbane City Council (BCC). The City of Greater Brisbane was an amalgam in 1925 of two cities, six towns and twelve shires. The new Department held the powers transferred from the MWSSB, and the Council under its 1925 Act had flood mitigation authority. The City Council examined the Royal Commission's proposals, decided on the Stanley site in 1930 and set the major dimensions of the dam. Flood hydrology was examined by relating sub-catchment daily flood rainfalls to the flood rating curve for Brisbane (Henderson 1896 and Williams 1901) to generate hydrographs (Bush 1930). On this basis the Council set the leading dimensions for a combined dam, dimensions which were subsequently adopted. An arch dam was considered but rejected in favour of a straight mass concrete gravity dam.

1932: the site finalised by Special Committee of the Bureau of Industry

With the onset of the 1930s depression, no funds were available. The Council appealed for assistance to the State Government but no money was forthcoming. In 1932 a new government set up a special committee of the Bureau of Industry to investigate the matter. The committee members were JR (later Sir John) Kemp, Commissioner of Main Roads; D Fison, Chief Engineer, Department of Harbours and Marine; (later Dr) WHR Nimmo, MRD Road Design Engineer; MB Salisbury, Irrigation and Water Supply Commission; JB Brigden, Director, Bureau of Industry; and L Morris, Central Technical College, Brisbane. The committee examined the proposals in detail, using a more advanced hydrological approach and applying probability analysis to the economics of flood mitigation. By a majority, the committee recommended the Stanley site, adopting the Council's overall proposed dimensions (Brigden 1934). In a minority report, L Morris strongly supported the Middle Creek alternative for its greater hydroelectric potential based on retaining flood waters for the purpose and discharging water rapidly in the advent of an approaching flood. This form of operation carries unacceptable risks and was rejected by the majority group although they had, briefly, considered the idea for Silverton, then the name for the dam. There were other major factors that would have made Morris' proposal uneconomical at the time, in particular a 16 MW hydro plant when the total Brisbane load was only 12 MW.

3. THE STANLEY RIVER WORKS BOARD

The Stanley River Works Board (SRWB) was established at the end of 1934 to design and construct the dam by day labour with Kemp as chairman, together with Brigden and also JD Story, the Public Service Commissioner, and representatives from Brisbane and Ipswich City Councils. Both Councils nominated their City Engineers. The Board commenced work in 1935 with HH Dare (formerly Commissioner, Water Conservation and Irrigation, NSW) as Consultant and Nimmo as Chief Engineer. Nimmo was succeeded as Chief Engineer in 1949 by JA (later Sir James) Holt, then by JE Kindler when Holt succeeded Kemp as Co-ordinator General of Public Works. CB Mott was seconded for three years from the Brisbane City Council in the 1930s to design and supervise access and township construction. He was succeeded by EM Shepherd, previously a member of the Brisbane River Bridge Board. G Sheil was Resident Engineer, succeeded by EL Richard from 1941 to 1943, then by RdeV Gipps from 1948.

Most of the engineers involved with or employed by the Board have been recognised for their professional contributions in two Institution of Engineers, Australia Queensland Division publications, *Eminent Queensland Engineers (1984)* and *Eminent Queensland Engineers Volume II (1999)*.

4. FLOOD MITIGATION COMBINED WITH URBAN WATER SUPPLY STORAGE

Somerset was clearly the first Australian dam to provide major flood mitigation, for the country's largest flood-prone population. Earlier dams had spillway gates but these were largely to limit reservoir levels to minimise the cost of the dam, any minor flood mitigation being incidental. Provision was made in the design of Hume Dam for side sealing spillway sector gates to be installed as a second stage of construction completed in 1961, but neither Nimmo (1966) nor Doherty (2000) mentioned whether the increased storage is used for flood mitigation. In fact, in the prestigious volume *Dam Technology in Australia 1850 - 1999*, published in 2000 by the Australian National Committee on Large Dams, there is no mention even of the words "flood mitigation" and the only listing for Somerset Dam is a single line entry in Table 3.3 *Australian gravity dams 1931-1961: New Dams* where only minimal dimensions are given. The dam has served Brisbane and Ipswich well, both in the major flood of 1974 in which damage saving amounted to hundreds of millions of dollars. Somerset Dam also saved damage in 1983 and 1999 in conjunction with Wivenhoe Dam.

The demarcation between the water supply and flood pondages was originally set 4.8m below spillway crest with the high capacity sluices to minimise flooding of the Kilcoy Branch low level Royston Railway Bridge. The margin was reduced to 4.6m to coincide with an even foot mark on the original level datum and then to 3.0m on advice from the Co-ordinator-General of Public Works (COG) Department based on a study in 1954 showing that the resultant very small loss in flood mitigation would increase water supply yields considerably, the change being implemented slowly as various road bridges were raised and the branch railway closed.

This final move divided the storage basin into the lower 40% for urban water supply reserve and the upper 60% for flood storage. This proportion was continued in Wivenhoe Dam, completed in 1986 on the Brisbane River, a short distance downstream of the formerly proposed Middle Creek site. Non-hydrologists should note that, large as the total flood storage in the two Brisbane Valley dams may seem, it is very small compared with the total volume of a major flood from a short period high intensity storm such as is common in the area. The best the existing dams can do, economically, is to take only the top off a major flood. In any case this area of a flood is where most damage occurs.

5. HYDROLOGY: UNIT GRAPHS

Sherman's seminal paper on unit graph theory was published in Engineering News Record in April 1932. Nimmo immediately battened on to the idea, using it in his 1933 hydrological studies for the Special Committee. Later he maintained (Nimmo 1966), that this was the first application of the method to Australian flood studies. It appears from available data that he made by far the major technical contribution to the musings of that committee. At the time he was Road Design Engineer in Queensland Main Roads Department with a Tasmanian background in hydroelectric and dam experience with emphasis on hydrology (Richard 1984). Nimmo worked out the constants at night while Richard did the calculations in the Main Roads office in working hours (The Main Roads Commissioner was a committee member). It is not clear whether Nimmo told his committee colleagues what he was up to as there is no mention in any of his *25* memoranda. The only possible reference is in Memo 15 written by a Colonel Pettis of the US Army Engineering Corps on the subject of time contours using analogies of soldiers marching from different distances. This had already been adequately covered (Ross 1921) but perhaps he felt a simpler text more appropriate for the non-technical committee members.

6. A HISTORY OF FLOODS

Floods are a potential danger to Brisbane's water supply system, but, so far, only short term interruptions have been experienced. In spite of raising the design height of Mt Crosby pumping station three metres following the experience of the 1890 Brisbane River flood, the bottom 4.3 metres of the then newly commissioned steam pumping station was inundated twice in 1893 for a few days. At that time, existing older sources (Enoggera and Gold Creek reservoirs) were able to cope.

In 1974, partial flooding of the station, by then electrified, was more serious but the problem was solved by careful operation by a dedicated staff helped by local volunteers from the flood-isolated area (Cossins 1995). Flood damage to river crossings left the high areas of South Brisbane waterless for several days in 1889 and the whole of Ipswich for two days in 1927.

The water supply system may have escaped lightly at these times but the populace suffered grievously on many occasions. A third of the population was driven from their homes twice in a fortnight in February 1893 and whole suburbs disappeared under water in the Australia Day weekend, January 1974, when 50,000 people had to evacuate and the flood damage amounted to $187million. At 2003 values, and taking into account the subsequent redevelopment in the flooded area, the damage would now exceed $1.5 billion.

The politics of flood mitigation has had a major input to both location and timing of the system's dams. Two investigations of the record double flood of 1893 (Henderson 1896 and Pennycuick 1899) grossly overestimated the cost of flood mitigation dams and resulted in the proposals being dropped (Cossins 1997). The extraordinary period of Brisbane River floods from 1887 to 1898 was followed by a long dry period lasting until 1927, which included the record drought from 1899 to 1903. The long dry spell was punctuated by only one moderate flood in 1908. The community had almost forgotten about floods when a small one occurred in 1927. This flood washed out one end of the recently completed Mt Crosby weir, depriving Ipswich of water for two days. This alerted the now much larger and more sophisticated community to the old fears of flooding. The Government used this flood to justify the Royal Commission into the MWSSB. The terms of the Commissioner's appointment particularly referred to both water supply and flood mitigation. The Board was proposing to build a water supply dam at the Somerset site but it had no mandate for flood mitigation.

As noted earlier, the Board was disbanded in 1928 and its powers vested in the BCC which, under its 1925 Act, had flood mitigation authority. Shortage of funds at the beginning of the great 1930s depression frustrated the Council's intentions to build a combined dam. An appeal to the Queensland Government was ineffectual as it was struggling with empty coffers itself. A 1931 flood, moderate in the Brisbane River but severe in Breakfast Creek, a city tributary, increased the pressure for flood mitigation. A 1932 change of government came to the Council's rescue by establishing the Stanley River Works Board (SRWB) in 1934 to design and build a combined water supply and flood mitigation dam at the Somerset site, by day labour, with Treasury loan funds.

7. FLOOD MITIGATION OPERATIONS

Potentially serious rain fell and tested the flood mitigation capacity of the dam in 1955. Construction of Somerset Dam was approaching completion, and a moderate flood was mitigated to the critical damage level in Brisbane.

As construction was coming to an end in 1958 the COG, being only a constructing authority, had to find an authority to take over and operate the dam. The COG proposed a regional body to take over the water supply systems of Brisbane and all its surrounding areas. A conference between the COG, the BCC Town Clerk and the Director of Local Government (LG) agreed to transfer the dam to the Council. The triumvirate also recommended the establishment of the Water Supply Planning Committee to advise on the best way of providing for the future water supply and flood mitigation requirements of Brisbane and the surrounding cities and shires. The Committee personnel were drawn from the BCC and the COG and LG Departments. Predictably, three engineers were chosen. The new committee functioned well, for instance recommending the water supply level of Somerset Dam be raised 1.3m to provide the reservation of the lower 40 percent of the storage for water supply and the upper 60 percent for flood mitigation.

The dam's next major mitigation performance occurred in January 1974. The meteorological event at that time was the movement further south than usual of a monsoonal trough of unusual strength and persistence, boosted by cyclone Wanda. The trough oscillated over the Brisbane River valley throughout the Australia Day weekend causing a large flood in the upper Brisbane valley but a smaller than usual Stanley River flood upstream of Somerset Dam (Heatherwick 1974a & 1974b and Shields 1974). Following the operating strategy devised in the 1930s (Nimmo 1933), and based on a principle understood by JB Henderson in 1894, the whole flow of the Stanley River was stored in Somerset Dam until the Upper Brisbane flood peak approached and passed the Stanley confluence, thus achieving the maximum available flood mitigation in the circumstances. When the Brisbane River flood peak, moving at five kilometres per hour, had passed far enough downstream of the confluence, a start was made to empty the flood storage compartment of the dam in preparation for a second flood such as had occurred in 1893. The discharge was started slowly and was to be increased steadily so as to empty the flood storage in two and a half days, at the same time causing minimum disturbance to the cities by keeping the river below flood level.

Serious cases of political and administrative intervention then occurred and the planned emptying was delayed. Fortunately the *quasi*-1893 second major cyclone, Pam, stayed 300km offshore and Brisbane, by the skin of its teeth, missed out on a disaster of modern American proportions. Investigation following the flood led to the Queensland Government enacting legislation requiring the person in charge of flood operations for all dams to be a suitably qualified and experienced engineer.

8. DESCRIPTION

Figures 1 and 2 below show the main features of the dam.

The dam is a 50m high, 305m long straight mass concrete structure built in interlocking monoliths with flexible copper seals. A 3m deep cut-off wall is located beneath the upstream heel. An 84m long, 8-bay central ogee spillway is equipped with a 7.9m long x 7.0m high radial sector gate in each monolith. A rectangular low level sluice 3.7m x 2.4m, is centrally located beneath each sector gate and is controlled by a tractor type gate. Sluices are steel lined for a short distance on either side of the gate shafts. Pairs of discharge regulators supplied by 2.7m diameter steel lined tunnels are on either side of the spillway. Steps cast into the concrete join the galleries. Non-spillway monoliths on either side of the spillway accommodating the regulator tunnels are 16.5m long with the remaining non spillway monoliths at 15.9m. Spillway monoliths are 11.4m and 7.9m long, the longer ones supporting a deck pier at each end for symmetrical loading to avoid twisting moments. Each pier carries bearings and counterweight tracks for sector gates. As sluice gates are located beneath the spillway crest, the hoist ropes are carried around sheaves and up through piers to the winches. The sluice gates, each 3.7m x 2.4m and weighing 13 tonnes, seal on the upstream side of the shafts which are dry when the gates are closed. There is, therefore, no downpull from almost closed gates as occurs with the emergency coaster gate. Adjustable rubber sealing strips are provided on the top and bottom of the gates and the sides have staunching bars which travel with the gates. Additional sealing is provided by injected sawdust. Sluice gates are operated only in the fully open position. Although gate shafts are fully open, a 600mm conduit admits air from the downstream face to prevent dangerous air currents in the inspection gallery and also possible undesirable vibrations.

Two galleries, each 2.0 m x 1.8 m, intercept drainage, the upper one also giving access to the sluice gates for maintenance. The lower gallery largely controls drainage. Steps cast into the concrete join the galleries. A foundation gallery is located a short distance behind the cut-off and a second one at the toe of the dam. Immediately behind each copper seal, a 150mm diameter inspection hole, half cored in each monolith, acts as a drain to the upper gallery. Similar holes then extend to the lower gallery. Other drains extend down from the lower gallery nine metres into rock behind the cut-off. The sluice gate shafts provide drainage for seepage water and the remaining monoliths have 150mm cored drains at three metre spacing, extending, as before, to the lower gallery. Each monolith has a brick foundation drain behind the cut-off and another about half way across the base drains to the lower gallery which discharges by gravity to the dissipator. In the event of a high flood, as in 1974, sump pumps dispose of the drainage. There are drainage holes also in the dissipator floor. The dissipator was designed on the basis of extensive model tests. It is 102m wide x 58m long with a baffle 3m high x 4.9m wide located 34m downstream of the toe. It ends with a sill 1.2m high x 1.8m wide.

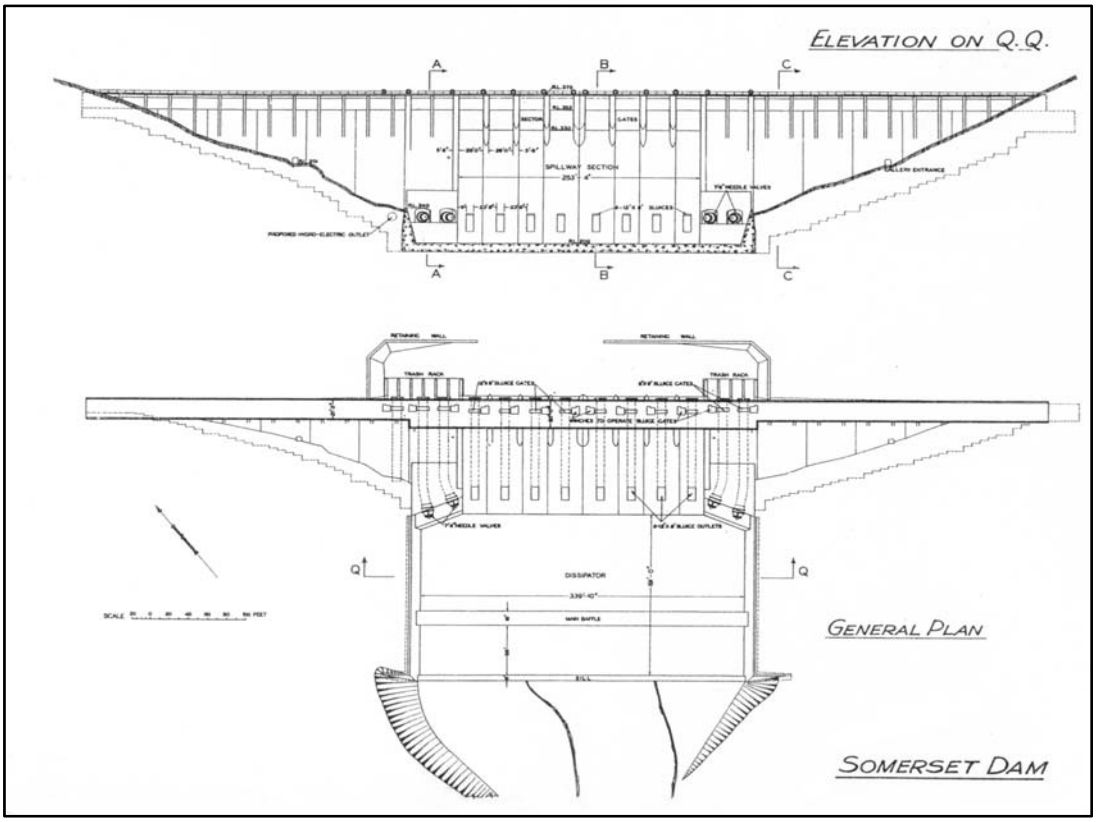

Figure 1: plan and elevation

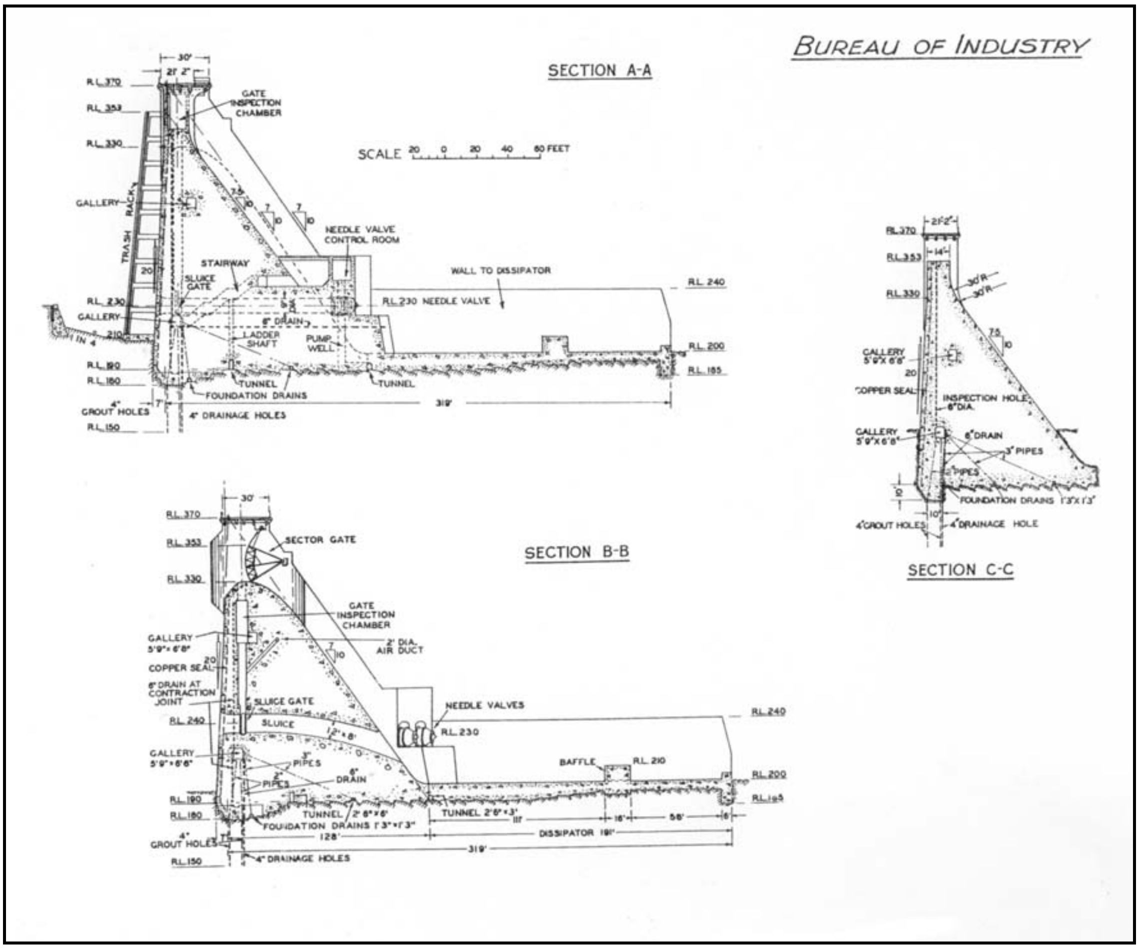

Figure 2: cross-sections

9. DAM STABILITY

The dam is built on a considerably jointed blue porphyritic rock (Ball 1940), the general depth of the foundations under the spillway and discharge valve sections being three to four metres. Foundations around the toe of the dam were grouted as soon as they were opened up, but general blanket grouting was not adopted. Deep, high pressure grouting was carried out through two rows of holes from the lower gallery into the rock foundation under the cut-off trench to form a grout curtain. The grouting technique was varied from time to time on the basis of experience (Richard, 1949) but could only be carried out when monoliths were sufficiently high to resist the uplift pressure. Some holes were left open after grouting to act as drains and also to measure uplift pressures. In spite of all precautions small amounts of water seep through the concrete of the dam, dissolving lime as they do so, and drip from gallery ceilings. Warm air from the hydroelectric plant circulating the galleries accelerates stalactite and stalagmite formation. Nevertheless, various dam experts have declared Somerset Dam to be one of the driest they have inspected. In the early 1960s Dr. Nimmo, acting as consultant to the Brisbane City Council for dam safety, directed a foundation pressure survey. Recorded pressures at the upstream heel were below the full uplift assumed in the design but there was a significant pressure difference between the two sides of the dam. Pressures on the eastern side were noticeably lower than on the western. Nimmo attributed this to the way foundation excavation had been carried out. Only unsound rock had been removed by hand on the eastern side, but the western area was excavated by machinery to a uniform depth regardless of the rock. As early as 1939, Nimmo was of the opinion that grout curtains could not prevent full uplift but could only slow percolation rates through the rock and that foundation drains were the key to reducing uplift pressures. He enlarged on this in a later paper (Nimmo 1959).

10. HYDROELECTRIC PLANT

It had been proposed to install a 3MW hydroelectric plant at the dam. However, the City Electric Light Company, which had by 1938 extended its high voltage grid to the area, advised that it was not prepared to take more than 500kW for ten hours of the day. A modest 750kW hydro electric plant was therefore decided upon and, but for war hold-ups, would probably have been installed. In 1951, Boving and Co, with whom the Board had corresponded since the late 1930s, made a proposal for a 3.2MVA installation. The unit consists of a horizontal shaft Boving turbine and Metropolitan-Vickers generator, control panels, controls and automatic voltage regulator. The Boving turbine is of a double runner Francis type and is designed to give high efficiency over a wide range of load. The two runners are controlled by a single inlet valve but each runner is provided with its own guide vanes and control servo-motor, this allowing water to be cut off from one runner at low loads for efficiency. The control circuitry has since been modified so that both sets of guide vanes open simultaneously. Governing is achieved by a permanent magnet generator and a Boving F10 actuator. With a generation voltage of 11 kV, the alternator for the plant, supplied by Metropolitan-Vickers, feeds via an 11/33 kV transformer directly into the high voltage system of the distribution authority connecting the northern and western systems at Kilcoy and Esk respectively, the two principal towns in what is now the Somerset Region. By 1953, the power grid had been greatly augmented and was able to accept the higher loading, and Boving's offer was accepted after the economics of the proposal had been verified. A unity power factor, due to the configuration of the transmission mains in the area, allowed an effective output of 4.0MW. The station enabled control of the 33kV system voltage level, and reduced network losses by up to 15%. It has enabled the electricity transmitter to defer the cost of overhead 33kV line reinforcement, and contributes to system reliability in the load growth area around Kilcoy. The generator could be brought on line quickly during system emergencies, facilitating rapid restoration of supply.

The plant, first commissioned in 1953, was shut down in 1978 allegedly for being uneconomic, re-commissioned in 1988 and run until January 2008. Its second major refurbishment is in progress in 2010.

11. CONSTRUCTION

Access

An access railway was considered but was rejected in favour of through roads which were started immediately. Electric power had to be brought from Brisbane as there was then no distribution system in Queensland outside cities and towns. Conditions were primitive for the first year until the road was completed from the railway at Esk, allowing material and machinery to be accessed in quantity. Nevertheless a concrete coffer dam allowed foundation exploratory drilling and excavation to start.

Accommodation

The township was sufficiently advanced for the first businesses to open early in 1936. The village, designed by CB Mott, was laid out as a suburban subdivision on the rock-strewn slope of Mount Brisbane with easy-graded gravel streets, stormwater drainage, street lights, reticulated water, electricity and sanitary sewers. These latter carried effluent from septic tanks to an Imhoff tank on the river bank, accumulated sludge being discharged just upstream of the swimming pool. The township and works were excised from Esk Shire and placed under the control of the Resident Engineer. Separate rental houses were available for families and barracks type accommodation for single men with three "ranches" supplying meals on a co-operative basis. There was a community hall, a state primary school with four teachers and 100 pupils, a police station, a wet canteen and two churches. Peak population reached 1000 with 150 families and a workforce of 450. Although the Board originally expected the village to be removed after completion, houses not required for permanent staff were sold in situ and proved popular for recreation, particularly *via* the through road from Kilcoy. As a consequence, the village is largely intact. At completion, the area reverted to Esk Shire. The village survives and is named Somerset Dam, a community within Somerset Region, a recent (2008) amalgamation of the former Shires of Esk and Kilcoy.

Employment was on a permanent basis as opposed to the more usual “relief” schemes at the time. There was some friction at the outset with workmen under the mistaken impression that it was just another “relief” scheme requiring only a nominal amount of work. There were publicised complaints to their MPs about the sweated labour.

Concrete

A suitable fine-grained hard rock was found at an elevation allowing gravity feed from the quarry to the crushers. An electric shovel worked the quarry and motor trucks carried the excavated rock to the crushers. A primary crusher reduced the rock to spall size then two rotary crushers brought it to about 8mm size, to be delivered into bins. A diesel locomotive then hauled this material in rail trucks to the mixers. At the restart of work in 1946, motor trucks were used for this purpose. Sand was obtained from the Stanley River, washed and stored at the site. Four horizontal mixers of 1.2m^3 capacity delivered concrete into 2.4m^3 bottom dump buckets, in pairs. All concrete materials were weigh-batched and air entrainment agents added. Two 10-tonne cableways of 1300m span delivered the concrete to working areas. (One cableway tower remains in position on rails at the eastern end of the dam). Concrete, consolidated by two-man vibrators, was placed in interlocking paddocks and water-cured for a day. Laitance was removed before the next pour. Richer concrete, with six 95-pound bags of cement per cubic yard (330kg/m^3), was placed in the 3.8m upstream part of each monolith and a weaker, four bag mixture, downstream, care being taken to intermix the two to prevent the formation of a vertical plane of separation due to different concrete characteristics. Steel formwork was used extensively.

Construction Plant

A large part of the construction plant came from Wyangala Dam in NSW. The whole of the fixed plant was electrically driven. The power supply was received at 33 kV from the Brisbane transmission line at the Council’s substation. It was there stepped down to 5 kV for the works and 240 V for general reticulation.

Construction Time

The original construction time was set at seven years, good progress being made until the British rearmament programme in 1938 held up deliveries of major components. It was then estimated that a further year would be required to finish the job, but the entry of Japan into World War II changed the programme radically. Four of the monoliths were left low to pass floods while the remainder were taken to a level which would provide a useful degree of flood mitigation. In late 1942 the low level outlets were temporarily sealed with timber baulks to provide water supply storage and a temporary sector valve fitted for water supply releases. For the first time in 117 years Brisbane had reliable headworks water storage.

Leaving only a small crew to complete deep foundation grouting, the construction force and some equipment was commandeered to build Cairncross Dock on the Brisbane River at Colmslie (now Morningside) as a war emergency project, the office staff having already taken the design to the stage where the dock work could start.

An attempt in 1946 to complete the dam in one year was frustrated by post war shortages of labour and materials. In 1948 a start was made to complete the dam in three years but shortages, particularly of form setters (carpenters), slowed the work. The formal finishing date is given as

1955, but tracks for the emergency coaster gate had yet to be installed on the upstream face with the reservoir full of water. The required floating coffer dam (Gipps and Pitt 1960) necessarily slowed completion until 1959, giving Somerset Dam the dubious distinction of the longest period (24 years) for the completion of a planned single stage dam construction.

12. SOME SIGNIFICANT FEATURES

Spillway Gates and Sluices

Dr Nimmo wrote, "*There was at the time no known precedent for the installation of large high pressure sluices immediately below a controlled spillway although similar arrangements were then being introduced in TVA* (Tennessee Valley Authority) *dams*" (Nimmo 1966). Here he was able to speak with authority. He had been in correspondence with American engineers since before the Special Committee (1932). Of the 25 memoranda he submitted to the Special Committee of the Bureau of Industry on technical matters, two were written by American engineers. There was also correspondence with the TVA about sluice gates which appeared to have excessive roller train clearances; but the TVA advised this was necessary due to the build up of debris, and so it proved to be. It appears that Somerset is the only dam in Australia with this configuration.

Discharge Regulators

Cone type discharge regulators are installed. Nimmo (1966) maintained, once again, that Somerset was their first Australian application. The decision must have been taken after 1938 but before 1942. He also held that concrete permeability measurements and air entrainment were another first for Somerset Dam.

The Village

Somerset was the second Australian dam for which a substantial village was built, being two years behind Canning. The Canning buildings were removed so it was necessary to employ archaeologists to research the area during the 1999 to 2000 remedial works. As noted earlier, the village, now named Somerset Dam, is still largely intact and mostly in its 1935 condition.

Ratio of Water Storage: Concrete

One of Nimmo's favourite comparisons was the ratio of reservoir storage to volume of concrete in a dam. He liked to point out Somerset's favourable ratio of 2430m^3 of water storage per cubic metre of concrete as compared with Burrinjuck as the next best at 2160. The earth banks of Hume always presented a comparison problem.

Comparisons with Canning

Neither plumb stones nor spalls were used at Somerset, as against granite spalls at Canning. The difference might have been due to different labour employment practices or even the lack of suitable material. Alternatively it could have been due to the Wyangala influence where no plumb stones were used. The Works Manager was imported from Wyangala along with construction plant. Another difference between the two dams lay in concrete delivery, Somerset using dump buckets against chutes at Canning. Nimmo rejected chutes due to the segregation they caused.

The WWII Workforce Training

The majority of Australian World War II defences were built in Queensland for which the trained Somerset workforce was invaluable (Brier 2002).

13. SUMMARY OF FEATURES

The following is a summary of Somerset Dam's claim to heritage fame**:**

- **Possible world first for high pressure sluices below spillway sector gates.**

Australian firsts in the following:

- **One structure for combined water supply and significant flood mitigation.**
- **Flood mitigation for the largest flood prone population in the country.**
- **Unit graphs used for flood derivation.**
- **Model experiments for design purposes.**
- **Concrete permeability measurements.**
- **Concrete air entrainment.**

Also:

- **Incorporated the latest Australian dam technology.**
- **Second Australian dam construction village, much still extant.**
- **Highest storage to capital cost ratio at completion.**
- **Provided reliable headworks urban water storage for Brisbane and Ipswich for the first time.**
- **Provided steady employment during the 1930s depression.**
- **Trained a workforce invaluable in World War II.**

14. SOME HERITAGE COMPARISONS

The following is largely taken from Nimmo (1966), Doherty (2000) and from conversations with SRWB office staff and others.

Large gravity dam technology in Australia has developed from the completion, in 1875, of Lower Stony Creek Dam in Victoria, the significant features incorporated in Somerset Dam having been introduced over the years. Examples are**:** internal drains in Cataract Dam completed in 1909, concrete placement in paddocks instead of the previous thin layers, Burrinjuck, (construction started in 1907 and prolonged until 1927), radial contraction joints, galleries and drains in Cordeaux (1926), cutoff, foundation drains and uplift provision in Wellington, (1933). Curtain grouting was used at Nepean (1935), as well as weigh-batching of sand and cement, with water measured to control slump (but stone was volume batched). Hume (1936) was the first to have an intentionally provided energy dissipator and provision was made to incorporate side sealing spillway sector gates in a second stage. (Somerset spillway gates have no side seals and are only used during floods). Concrete test cylinders seem first to have been taken at Mount Bold (1937). All these features, and keyed contraction joints, were incorporated in Canning (1940) (Moulds 2001) and in Somerset (1942: assumed date of original construction schedule). On the basis of design periods rather than construction times, a great advance in Australian dam technology was made between about 1920 and 1935. A ten year period followed due to World War II and its aftermath during which no new dams were commenced. However, in that time, designers were able to take advantage of overseas and local technological improvements. It also became clear that the Somerset sluice configuration was not as effective as side-sealed spillway sector gates. The era culminating in Canning and Somerset Dams is a distinct phase. Although the Canning is the very much higher dam of the two, the technology is virtually identical.

15. CONCLUSION

In view of its many innovative features and of its importance in mitigating major floods for the largest flood-prone population in Australia, it is considered that Somerset Dam is worthy of an Engineering Australia Heritage Award.

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John Douglas Story (1869-1966), Public Service Commissioner, Queensland

Story was on the Public Service Superannuation Board 1913-1942; chief crown advocate before the Industrial Commission on public service matters; and a member of the Bureau of Industry. He served on boards which constructed the new university at St Lucia, **built Somerset Dam,** and erected the bridge across the Brisbane River from Kangaroo Point to Fortitude Valley, named in his honour in 1940. Following his retirement in 1939 Story became honorary full-time vice-chancellor at the University of Queensland. Succeeded by Professor Fred Schonell as Queensland's first salaried vice-chancellor, Story retired in 1960, but remained on the senate of the university until 1963. He was honoured by the naming of the new J.D. Story Administration Building in 1965.